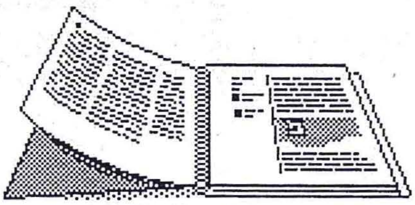
Zentrum für Allgemeine Sprachwissenschaft,
Sprachtypologie und Universalienforschung

ZAS Papers in Linguistics

Volume 19
December 2000



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ISSN 1435-9588

Investigations in Prosodic Phonology: The Role of the Foot and the Phonological Word

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ZAS Papers in Linguistics 19, 2000

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Contents

On the (non-)recursivity of the prosodic word in Polish*

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1 The problem

The present paper investigates the relationship between the morphological word and the prosodic word in Polish sequences consisting of proclitics and lexical words. Let us start by examining the placement of primary and secondary stresses in the phrases given in (1) in careful Polish.[1] Stressed syllables are marked below by capitalizing the appropriate vowels:

(1) a. pO	polowAniu	b. dlA	nieszczęśnIka
after	hunting.loc.sg	for	wretch.gen.sg
'after the hunting'		'for the/a wretched person'	

In (2) the phrases from (1) are represented as sequences of feet. The digit 1 stands for the primary stress and 2 for secondary (or tertiary) stresses (as in Kraska-Szlenk 1995 or Rubach and Booij 1985). Polish words have penultimate stress, i.e. a prosodic word (henceforth PWd) has a prominent trochaic foot at the right edge.[2] Following McCarthy and Prince (1993) and Selkirk (1995), I assume that feet are binary and that some unstressed syllables remain unparsed, i.e. *-lo-* in (2a) and *-szczęś-* in (2b).

(2) a. (2 0) 0 (1 0) b. (2 0) 0 (1 0)

po po lo wa niu (=1a) dla nie szczęś ni ka (=1b)

The monosyllabic preposition and the initial syllable of the host in each phrase in (2) form a foot. McCarthy and Prince (1993:129) assert that '[b]y the Prosodic Hierarchy, no foot can

* This is a revised version of the talk given at the workshop 'Das Wort in der Phonologie' during the 22nd meeting of the Linguistic Association of Germany (DGfS) in Marburg in March 2000. I would like to express my gratitude to the participants of the workshop for their questions and remarks, and to the editors of the present volume for their help in preparing the final version of the manuscript. I am particularly indebted to Grażyna Rowicka and Marzena Rochoń for reading carefully an earlier version of the paper. I would also like to thank Geert Booij and Gienek Cyran for their comments. I am alone responsible for any remaining errors.

1 The phrases quoted here from Polish occur in their standard orthographic form. The letter 'w' is used to represent a voiced labiodental fricative (i.e. the sound transcribed as [v] in IPA transcription). The letter 'ł' represents a labio-velar semivowel (i.e. [w] in IPA transcription) and 'j' stands a palatal semivowel. The digraph 'ch' is used for a voiceless velar fricative [x]. The digraphs 'cz' and 'dż' stand for post-alveolar affricates (voiceless and voiced, respectively). Dental-alveolar affricates are represented in spelling as 'c' (voiceless) and 'dz' (voiced). Post-alveolar fricatives are spelled 'sz' (voiceless) and 'ż' (voiced, with the variant spelling being 'rz'). Prepalatal equivalents of dental-alveolar and post-alveolar consonants are represented as sequences of such consonants and the letter 'i' (e.g. 'i', 'zi') or as the symbols 'ś', 'ź', 'ć', 'dź' and 'ń'. The letter 'y' stands for a high central vowel. Nasal vowels are spelled 'ą' (back) and 'ę' (front).

2 A useful discussion of stress pattern in Polish can be found in Hayes (1995).

straddle two PrWd's'. This assumption allows them to account for stress placement in Polish compounds, where each stem/word is a separate domain for foot-parsing (as will be shown at greater detail in section 3). Consequently, the proclitic plus host combinations in (2) cannot contain internal PWd brackets. Since the structures in (3a) and (3a') are prohibited by the Prosodic Hierarchy (and cannot be generated in GEN), I propose (3b) as the prosodic representation of (2a).[3]

(3) a. $*[(2\ [0)\ 0\ (1\ 0)]_{PWd}]_{PWd}$ a'. $*[(2\ [0)\ 0\ (1\ 0)]_{PWd}]_{PPh}$

b. $[(2\ 0)\ 0\ (1\ 0)]_{PWd}$

The fact that (3b) exhibits no nested structure (i.e. it contains neither $[\ [\ ]_{PWd}]_{PPh}$ nor $[\ [\ ]_{PWd}]_{PWd}$) constitutes a violation of the constraints in (4), which align the edges of lexical (i.e. non-functional) words with the edges of prosodic words, familiar from McCarthy and Prince (1993) and Selkirk (1995):

(4) *Align (Lex, PWd)*: 'Align the right/left edge of each lexical word with the right/left edge of some prosodic word'

By virtue of (4), we would expect a PWd edge preceding thc head noun *polowaniu* 'hunting.loc.sg' in (1a). Moreover, if we assume that the proclitic plus host sequences in (1) and (2) do not exhibit nested prosodic structure, we come across another problem. The main (lexical) stress in Polish is placed on the penultimate syllable (Ft-Form Trochaic) and the feet headed by syllables carrying secondary stresses are constructed from left to right (as is shown in Hayes 1995 or McCarthy and Prince 1993). Rubach and Booij (1985) observe that in non-derived or non-prefixed words containing an odd number of syllables (but more than five, e.g. seven or nine), the unparsed syllable is located immediately preceding the head foot, as in (5a) and (5c). In proclitic+host sequences consisting of an odd number of syllables (more than five), the unfooted syllable comes right after the left-most foot, as in (5b). In (5) a syllable σ with some degree of stress is preceded by an accent mark, as in $'\sigma$. The presence of stress is additionally marked by capitalizing the appropriate vowel. Dots indicate syllable division.

[3] There appears to be yet another option of bracketing (2a), given below as (i). However, such a bracketing incurs a single violation of the constraint on Foot Binarity (since it contains a degenerate one-syllable foot), a double violation of Parse σ (by having two unparsed syllables) and a double violation of Al-L (Ft, PWd).

(5) a. A.kor.dE.o.ni.stA.mi 'accordion-player.instr.pl'
('σ σ) ('σ σ) σ ('σ σ)
b. dlA. a.kor.dE.o.nI.stów 'for (the) accordion-player.gen.pl. '
('σ σ) σ ('σ σ) ('σ σ)
c. Or.ga.nI.za.to.rA.mi 'organizer.instr.pl'
('σ σ) ('σ σ) σ ('σ σ)
d. dlA. or.ga.nI.za.tO.rów 'for (the) organizer.gen.pl. '
('σ σ) σ ('σ σ) ('σ σ)

We will attempt to account for these data below.

2 Earlier accounts of the data

The prosodization in (3b) runs against other accounts of the clitic plus host combinations in Polish proposed in the literature. Rubach and Booij (1985) regard preposition plus lexical word combinations as phonological phrases (PPh), which corresponds roughly to the Polish term 'zestrój akcentowy' (accentual group) used in Dłuska's (1976).[4] They do not divide PPhs into feet or into prosodic words, since they employ grids in their analyses.[5] When analysing phrases consisting of prepositions and nouns, Rubach and Booij postulate that monosyllabic minor category words receive no lexical stress. Rules of Beat Addition (which are euphony rules in terms of Selkirk 1984) are assumed to reapply after every text-to-grid rule (e.g. Main Stress Rule and Nuclear Stress Rules) to account for the occurrence of rhythmic stresses and the avoidance of stress clashes and lapses.[6] The rule of Prestress Initial, quoted in (5) after Rubach and Booij (1985), applies to phrases such as those in (1) and moves the secondary stress from the initial syllable of the head noun to the phrase initial position.

(6) Prestress Initial $\begin{array}{ccc} & * & \\ * & * & * \end{array} \rightarrow \begin{array}{ccc} * & & \\ * & * & * \end{array}$

(i) $[(2)\ [\ 0\ 0\ (1\ 0)]_{PWd}]_{PWd/PPh}$

[4] The Phonological Phrase is defined in Rubach and Booij (1985) as consisting of one word carrying the main (i.e. lexical) stress and containing optionally monosyllabic words which normally are not members of major lexical categories.

[5] Nespor and Vogel (1989:115), when discussing Polish data from Rubach and Booij (1985), similarly decide that 'the alternations observed are purely rhythmic. Thus, they are most appropriately accounted for by grid operations and do not require a richer foot structure in the prosodic component.' In contrast to Rubach and Booij (1985) and McCarthy and Prince (1993), Nespor and Vogel (1986, 1989) construct flat n-ary branching feet, containing as many as eight syllables.

[6] They also employ Selkirk's (1984) Textual Prominence Preservation Condition to predict that euphony rules may not undo the prominence relations assigned by text-to-grid rules (such as the Main Stress Rule).

Rubach and Booij's (1985) analysis is incompatible with the basic tenets of non-derivational Optimality Theory (OT) as formulated in McCarthy and Prince (1993), which allows neither for stress movement nor for cyclic rule application. In non-derivational one-level OT analysis there can be no erasure of PWd internal brackets at the end of a stratum to allow for foot formation across words (as is proposed within a derivational theory of Lexical Phonology adopted in Rubach and Booij 1990).[7]

Let us now summarize briefly the analysis of the clitic plus host combinations in a monograph couched within the framework of OT, namely in Kraska-Szlenk (1995). Kraska-Szlenk (1995) treats the phrases in (1)-(2) as constituting Phonological Units (Punits). This corresponds roughly to the prosodic domain of the 'clitic group' postulated in Nespor and Vogel (1986). To capture the essence of Rubach and Booij's Prestress Initial, Kraska-Szlenk puts forward the constraint in (7), which aligns the left edge of a foot with the left edge of a clitic group (i.e. her 'Punit').[8]

(7) Align the left edge of a foot with the left edge of a Punit (clitic group)

To predict that the presence of a monosyllabic preposition triggers a modification of the edges only of the initial foot in the noun, she takes recourse to the Identity Prominence constraint (8b). This constraint, which is a version of the Base Identity postulated in Kenstowicz (1996), evaluates the metrification for the [X#Y] structure by matching it to the stress contours of the constituents [X] and [Y] occurring in isolation. It can be regarded as a subtype of Output-Output (i.e. O-O) constraints, proposed in McCarthy and Prince (1995). The purpose of O-O constraints is to ensure phonological identity (or similarity) of morphologically related words.

(8)a. Base-Identity (Kenstowicz 1996:370)
'Given an input structure [X Y] output candidates are evaluated for how well they match [X] and [Y] if the latter occur as independent words.'
b. Identity-Prominence (Kraska-Szlenk 1995:131)
'Prominence has to be aligned with the corresponding syllables of the outputs in the identity relation.'

[7] An issue which remains highly controversial at the moment is whether some serial derivations should be allowed in OT, and how such a modification would affect the overall architecture of the theory. While Booij (1997) allows for both multi-level OT and O-O correspondence constraints, Rubach (2000) in his DOT (Derivational Optimality Theory) explicitly rejects all the so-called OT auxiliary theories, such as O-O correspondence theory, sympathy theory, and Max(F) theory. Some potentially undesirable consequences of introducing derivations and levels of constraint evaluations in OT are pointed out in McCarthy (2000:186).

[8] This constraint is ranked higher than her Align-Foot (=Al-L (Ft,Pwd)), which aligns the left edge of each foot with the left edge of some PWd. Constraints referring to the right edge, postulated in Kraska-Szlenk (1995), include, among others, Align (Pwd, R, Ft, R) and Align (Punit, R, Mwd, R).

Base-Identity in (8a) (or Identity-Prominence in 8b) is ranked above Parse-σ, which says that all syllables must be parsed as feet. It is violable gradiently and counts the number of instances in which the prominence of a syllable is different in the base and the related form. The joint application of the constraints in (7) and (8) produces the foot parsing in (9a). The alternative foot parsing in (9a') is less felicitous (and is ruled out) due to numerous violations of Base-Identity.[9]

(9) a. do wy. a. lie. no. wa. ne.go — 'to (an) alienated (person)'
(2 0) 0 (2 0) 0 (1 0)
a'. *(2 0)(2 0) (2 0) (1 0)
b. Base:
wy. a. lie. no. wa. ne.go — 'alienated.gen.sg'
(2 0) (2 0) 0 (1 0)

Let us point out that Kraska-Szlenk employs in her analysis the notion of Mword (Morphosyntactic word) defined as in (10) below:

(10) Morphosyntactic word (Mwd) is a final product of the morphological component of grammar. It should contain a root and an inflectional suffix (cf. Kraska-Szlenk 1995:144).

Mwds are mainly lexical words but polysyllabic function words (e.g. prepositions, pronouns) also count as Mwds. A Mwd does not contain clitics, such as the conditional particle *-by*. A Punit such as *po polowaniu* 'after hunting' in (1a) contains one Mword, i.e. *polowaniu* 'hunting-loc.sg'. Kraska-Szlenk proposes constraints aligning the edges of prosodic domains (such as Foot, PWd or Punit) with the edges of Mword. It seems, thus, that Mword is a rough equivalent of Lex in McCarthy and Prince (1993) or Selkirk (1995). However, Kraska-Szlenk makes it clear that she uses Mword both as a morphosyntactic object (corresponding to Lex) and as a phonological object (corresponding to Pwd in Prince and Smolensky 1993). Moreover, she postulates the domain of a Pword (prosodic word), which is characteristically smaller than Mword (for instance, it does not include prefixes). Her Pword is relevant for external sandhi phenomena, such as syllable-allignment or devoicing. This profusion of phonological domains and ambiguity of Mword makes her analyses fairly complicated and potentially confusing.

[9] The prosodization of the Base given in (9b) after Kraska-Szlenk (1995) differs from my own intuitions. I would prefer to place the secondary stresses in the prefixed word *wyalienowanego* 'alienated, pf. gen.sg' in such a way that it resembles their distribution in the non-prefixed word *alienowanego* 'alienated, impf, gen.sg', where the unfooted syllable follows the syllable bearing the main stress. See footnote 15 in section 3.1. for more discussion.

An even more serious objection to Kraska-Szlenk's framework is that she does not make the relationship between Punit, Mword (as a phonological object) and Pword explicit enough. When discussing prosodization of clitic plus host groups, she considers alternative foot structures of strings of syllables corresponding to Punits. It appears that in her representations the level of foot is immediately dominated by the level of Punits.[10] Such an assumption would constitute a violation of one of the constraints on prosodic domination, namely Headedness (cf. Selkirk 1995). Selkirk (1995) restates the Strict Layer Hypothesis, formulated in Selkirk (1984) and Nespor and Vogel (1986), as a junction of the four constraints on prosodic domination in (11).[11] She proposes that Nonrecursitivity and Exhaustivity are potentially violable, whereas Layeredness and Headedness (as stated in 11c, d) are not. The latter constraints are said to 'embody the essence of the Strict Layer Hypothesis' and to hold universally in all phonological representations.

(11) *Constraints on Prosodic Domination* (Selkirk 1995)

a. *Nonrecursitivity*

No C^i dominates C^j, $i = j$

E.g. *NonRec$_{PWd}$*: A prosodic word (PWd) may not dominate a PWd.

b. *Exhaustivity*:

No C^i immediately dominates a C^j, $j < i\text{-}1$

E.g. *Exh$_{PPh}$* : A phonological phrase (PPh) may dominate only PWd.

c. *Layeredness*

No C^i dominates a C^j, $j>i$

e.g. 'No σ dominates a Ft.'

d. *Headedness*

Any C^i must dominate a C^{i-1} (except if $C^i = \sigma$),

e.g. 'A PWd must dominate a Ft.'

While we reject the exact details of Kraska-Szlenk's analysis, we will adopt below a part of her theory, namely the use of the Base Identity (or Identity Prominence) constraint and the use of the notion of Mword as a morphosyntactic object.

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[10] She says on page 141 that 'the Pword is constraint-driven and not present in the input form'. On the other hand, she observes on page 152 that domains in Polish are organized in the embedded fashion, i.e. $_{Pu}[\ldots_{Mw}[\ldots_{Pw}[\ldots]_{Pw}\ldots]_{Mw}\ldots]_{Pu}$. With reference to Mword, she suggests, moreover, that Lex=Pwd constraint from Prince and Smolensky (1993) is never violated in Polish, consequently Mword as a morphosyntactic object always corresponds to Mword as a phonological object (see section 5 of the present paper for the opposite assumption). She proposes that Mword is important for foot structure and 'prone to stress constraints' (p. 145, 157).

[11] The Strict Layer Hypothesis (SLH) states: 'A prosodic constituent of level C^i can immediately dominate only constituents in the next level down in the prosodic hierarchy, C^{i-1}.' (cf. Selkirk 1984, Nespor and Vogel 1986).

3 Evidence from other phonological processes

3.1 Syllabification in Polish

An undesirable consequence of the metrical structure proposed for preposition plus noun combinations in (3b), repeated for convenience below, is that it presents difficulty in predicting facts concerning syllabification.

(3b) $[(2\ 0)\ 0\ (1\ 0)]_{PWd}$

As observed in, among others, Rubach and Booij (1990:442), Polish does not permit syllabification between words or across the prefix+stem juncture. In spite of the preference for optimizing onsets, the word-final consonant in the preposition in (12a) cannot be syllabified with the following word-initial vowel of the lexical word, as shown in (12c). The word-initial vowel can be optionally preceded by a glottal stop, as in (12b). The dots in (12b, c) indicate the syllable division.[12]

(12) a. przed oddawaniem (orthographic form)
'before returning'
b. przed.ʔod.da.wa.niem
c. *prze.dod.da.wa.niem

The same phenomenon, namely a ban on trans-junctural syllabification, can be observed in the case of prefixed derivatives.[13] This is illustrated in (13). The data in (14) show, in contrast, that a stem or root-final consonant can be syllabified together with the suffix-initial vowel, and that glottal stop insertion is impossible.

(13) a. nadopiekuńczy 'over-protective' (*nad-*'over' + *opiekuńczy* 'protective')
b. nad.ʔo.pie.kuń.czy
c.*na.do.pie.kuń.czy

(14) a. grubas 'a fat man' (*gruby* 'fat' + the nominalizing suffix *-as*)
b. gru.bas.
c. *grub.ʔas.

[12] Syllabification and the glottal stop insertion is also discussed in Rochoń (2000), who highlights the relevance of prosodic constituents as domains of phonological processes in Polish.

[13] Szpyra (1989) notes that resyllabification across prefix+stem juncture is possible for some words. (I am grateful to Marzena Rochoń and Grażyna Rowicka for bringing this point to my attention.) The verbs *rozognić* 'to heat, to inflame' and *nadużyć* 'to abuse', containing the prefixes *roz-* and *nad-*, can be syllabified either as *roz.og.nić* and *nad.u.żyć* (with a syllable edge following the prefix) or as *ro.zog.nić* and *na.du.żyć*. In my view, the first syllabification is preferred in careful speech. Szpyra (1989) regards the two syllabifications in such prefixed words as resulting from the double application of the syllabification process in the course of the derivation. The first syllabification process operates when the prefix and the verb constitute separate prosodic units. Once the prefix and the stem are reanalyzed as a single prosodic word, the resyllabification can apply once again. I will propose another tentative account of this phenomenon in section 5.

McCarthy and Prince (1993:128) account for the ban on trans-junctural syllabification in Polish[14] by employing the constraint Align (Stem, L, PWd, L). They say: 'A constraint of the Align-left type requires that the left edge of each stem coincide with the left edge of a PrWd. But it also entails that the left edge of the stem not lie *within* a syllable or *within* a foot, since σ and Ft are subordinate to PrWd in the Prosodic Hierarchy. Thus a well-aligned stem-edge is opaque to syllable-parsing and to foot-parsing.'

This analysis is not available for the data in (12) and (13) once we adopt the assumption that there are no internal PWd brackets inside strings consisting of a preposition and its host, or a prefix and a stem. Note that the prosodization of the prefixed word in (13a), represented in (15a), resembles the stress distribution in prepositon+lexical word sequences in (2), since the word-initial prefix *nad-* bears a secondary stress and forms a foot with the stem-initial syllable. Moreover, if the prefixed word contains an odd number of syllables (greater than five), as in (15b), the unfooted syllable will follow immediately the left-most foot.[15]

(15) a. nAd. o. pie. kUń.czy 'over-protective' (=13a)
(2 0) 0 (1 0)
b. przE.or. ga.nI. zo.wA. nie 're-organizing.pf' (*prze*-'re-', *organizowanie* 'organizing, impf')
(2 0) 0 (2 0) (1 0)

The location of the unfooted syllable in the prefixed noun in (15b) is the same as in the preposition plus host sequences (illustrated in 5), which shows that both types of combinations call for a unified analysis.

3.2 Yer Vocalization, Palatal Assimilation and Lexical Stress Assignment

Another phonological process which is regarded as diagnostic of a word boundary (the so-called external sandhi effects) is yer vocalization. Yers or 'fleeting vowels' (ø) are vocalized as /e/ before another yer in the same phonological domain, otherwise they do not surface.[16]

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[14] They discuss the data from Booij and Rubach (1990), e.g. the impossibility of resyllabification in the prefixed verb *rozognić* 'to heat' and in the compound *mechanizm obronny* 'defense mechanism'.

[15] Some speakers of Polish allow for another distribution of stresses in (15b), i.e. one where the unfooted syllable surfaces immediately in front of the right-most foot. This variability in stress pattern resembles the problem of the double syllabification of prefixed words, mentioned in footnote 13. The prefixed words behave with respect to syllabification and stress placement either as non-derived words, or as preposition plus lexical word sequences.

[16] This is the essence of the phonological rule called Lower, as proposed in Gussmann (1980), Rubach (1984), or Szpyra (1989). Szpyra (1992a) offers a different account of the behaviour of Polish yers, in which she takes recourse to syllabic well-formedness. She claims that a yer vocalizes when the consonant that follows cannot be incorporated into any syllable. Let us further note that the raising of the vowel /o/ to /u/ is regarded by some phonologists as an indication of a PWd edge. However, it is also possible to treat it as a process occurring in closed syllables.

Rubach (1984) and Szpyra (1989, 1992b) assume that prefixes and roots constitute separate phonological domains, i.e. separate phonological words. Prefixed words are then analyzed similarly to compounds, e.g. the verb *oddawać* 'to give back', containing the prefix *od-* and stem *dawać,* is analyzed phonologically as [[odø] [dawać]]. The verb *zbratać* 'to become brothers', containing the prefix *z-* and the stem *bratać,* is bracketed as [[zø][bratać]]. Another analysis of such strings is outlined in Rubach and Booij (1990) and Rowicka (1999). They postulate that prefixes are usually procliticized onto the root, i.e. [odø [dawać]]. Rowicka (1999) observes, furthermore, that in order to account for the behaviour of yers in prefixed verbs containing vowelless roots in Polish, it is necessary to propose that in such cases the prefix belongs to the same phonological domain as the root, as in *odebrać* 'to get back' [odø+børać] from *od-* and *brać* 'to take', or in *podeschnąć* 'to become partly dry' from *pod-* and *schnąć* 'to become dry'.

The 'troublesome' yers in prefixes attached to vowelless roots are indicated in (16) by underlining. Such yers would be predicted not to surface if a PWd bracket were postulated at the left edge of a stem:

(16) a. odesłać 'to send away, pf' (cf. odsyłać 'to send away, impf', root /søł/)
b. podeschnąć 'to become partly dry, pf' (cf. podsychać 'to become partly dry, impf', root /søx/)
c. podebrać 'to filch, to pilfer, pf' (cf. podbierać 'to filch, to pilfer, impf', root /bør/)

Consequently, the data from vowel-zero alternations call for a contrast between 'synthetic affixation' (i.e. [prefix+stem]) in the case of prefixed verbs containing vowelless roots, and 'analytic affixation' (i.e. [prefix [stem]]) in the case of the remaining prefixed verbs.[17]

The distinction between analytic and synthetic affixation turns out to be irrelevant for predicting the placement of the main stress in a verb. For the purposes of lexical stress assignment, both types of prefixed verbs are regarded as constituting a single prosodic domain, i.e. [prefix+stem].[18] The main stress can fall on a syllable in the prefix, if it happens to be penultimate in the verb, e.g. *oddać* 'to return' (i.e. *od-* and *dać*), *odebrać* 'to take back' (i.e. *ode-* and *brać*).

To further complicate the picture, let us add that the evidence from palatal assimilation, discussed in Gussmann (1999), Rowicka (1999) and Szpyra (1989), suggests that prefixes attached both to vowelless roots and to roots containing full vowels should be analyzed as

[17] Although prefixes and prepositions pattern together with respect to syllabification, they behave differently with respect to yer vocalization, as is shown in Szpyra (1989, 1992b). Prepositions do not belong to the same prosodic domain as hosts, therefore the preposition-final yer does not vocalize as /e/ in (ii)
(ii) a. pod schnącą bielizną 'under the laundry which is/was drying' (not: *pode schnącą bielizną)
b. nad tkaniną 'above the material' (not: *nade tkaniną).

[18] Szpyra (1989, 1992b) proposes the so-called Monosyllable rule which reinterprets a sequence of two prosodic words as one prosodic word (if one of those words is monosyllabic, e.g. a prefix).

belonging to a different domain than the stem/root. Rowicka (1999) shows that there is no palatalisation of the consonant /z/ in front of the prefix, which suggests a nested domain [z[nieść]] for *znieść* 'to bear'. Palatal assimilation of the spirant /z/ in front of the palatalized nasal or lateral is obligatory domain-internally, as in the word *bli[ź]nie* 'scar, dat.sg'.

Gussmann (1999) and Szpyra (1989, 1992b) show that spirants /s, z/ undergo palatal assimilation in front of coronal obstruents. Gussmann (1999) argues that such assimilation is obligatory domain-internally and domain-initially, as in [ść]*eżka* 'path, dim.', [źdź]*bło* 'blade (of grass)'. It is optional across words and across a prefix+stem juncture, as in [zø [działać]] for *zdziałać* 'to take action, to have effect' (*zdź*-or *źdź*-). Furthermore, palatal assimilation of /s/ is obligatory across the prefix-stem juncture in *ścinać* 'to cut down, impf', *ścierać* 'to wipe, impf').[19] The prefix *s*- is parsed together with the stem: [ś+cierać] (cf. Rowicka 1999). In (17)-(19) below we illustrate clashes between the predictions of the processes discussed in this section:

A. Yer-behaviour:

(17) a. rozedrzeć	'to tear, pf' (from *roz*- and *drzeć* 'to tear, pf')
[rozø+dørzeć]:	synthetic affixation [pref+root]
b. rozciągnąć	'to stretch, pf' (from *roz*- and *ciągnąć* 'to pull, impf')
[rozø[ciągnąć]]:	analytic affixation [pref[root]]

B. Palatal assimilation

(18) a. rozdzierać	'to tear, impf' (DI from *rozedrzeć* 'to tear, pf')
[rozø [dzierać]]:	analytic affixation, optional pal.ass. ro[zdź]erać or ro[źdź]erać
b. rozciągnąć	'to stretch, pf'
	analytic. affixation [pref [root]], optional pal.ass. in ro[sć]ągnąć or ro[ść]ągnąć
c. ścinać	'to cut down, impf'
	synthetic affixation [prefix+root], obligatory pal.ass.in [ść]inać

C. Lexical stress assignment:

(19) a. ro.(ze.drze)	'tear.fut.1st.sg.', synthetic prefixation [prefix+root]
σ (σ!! σ)	
b. (roz.dać)	'to give away', synthetic prefixation [pref+root]
(σ! σ)	

[19] Szpyra (1989:218) attributes the obligatoriness of palatal assimilation in *ścinać* 'to cut down' to the fact that it is marked in spelling, which suggests that the process is morphologized at the word level.

Since the data from processes of segmental phonology in (17)-(19) and prosodic phonology (e.g. syllabification) do not provide conclusive (and unambiguous) evidence for analyzing prefixes and stems as being in separate phonological domains,[20] we will assume here that it is possible to keep the structure in (3b) (i.e. to analyze proclitic/prefix+host/stem sequences as single PWds).[21] We will employ the analysis of clitics/affixes proposed for Makassarese in Basri et al. (1998, 1999) to predict the absence of syllabification across words or across prefix juncture. It will be briefly summarized in the next section.

4 The analysis of Makassarese clitics

Basri et al. (1998, 1999) postulate that languages differ in the relative ranking of Lex-PWd Alignment constraints and constraints on Prosodic Domination, quoted below after Basri et al. (1998:1).

(20) *Lex-PWd Alignment Constraints*

a. *$Align_L$ Lex*

Align (Lex, L, PWd, L) (=For any Lex there is a PWd such that the Left edges of Lex and PWd coincide)

b. *$Align_R$ Lex*

Align (Lex, R, PWd, R) (=For any Lex there is a PWd such that the Right edges of Lex and PWd coincide)

(21) *Constraints on Prosodic Domination*

where C^i is a prosodic category of level i in the prosodic hierarchy

a. *Nonrecursitivity*

No C^i dominates C^j, $i = j$

E.g. *$NonRec_{PWd}$*: A prosodic word (PWd) may not dominate a PWd.

b. *Exhaustivity*:

No C^i immediately dominates a C^j, $j < i-1$

E.g. *Exh_{PPh}* : A phonological phrase (PPh) may dominate only PWd.

[20] It is pointed out, e.g. in Kraska-Szlenk (1995), that there is evidence for the PWd edge between a host and an enclitic, but not between a stem and a suffix. This evidence is not fully conclusive either. In strings containing the hortative plural marker *-my*, the placement of the main stress on the penultimate syllable, as in *przeróbmy* 'let's remake', indicates that it functions as a single prosodic domain, presumably PWd. On the other hand, the devoicing of the obstruent /b/ in front of a nasal is indicative of a word-boundary preceding the morpheme *-my* (word-internally we observe no obstruent devoicing in front of sonorants, cf. *podobny* 'similar', *magma* 'magma').

[21] Rowicka (1999), following Polgardi (1998), assumes that phonotactic domains (i.e. domains relevant for processes of segmental phonology) are distinct from prosodic structure. Let us note that Parker (1997) proposes two disjoint metrical tiers in his OT analysis of Huariapano: one tier is relevant for segmental phonology, whereas the other tier is relevant for stress placement.

Basri et al (1998:17ff) predict the following typology of languages by changing the relative ranking of the constraints given above in (20)-(21):

(22) Type A Language: Align Lex >> $\text{NonRec}_{\text{PWd}}$ >> Exh_{PPh}
Type B Language: Align Lex >> Exh_{PPh} >> $\text{NonRec}_{\text{PWd}}$
Type C Language: $\text{NonRec}_{\text{PWd}}$, Exh Exh_{PPh} >> Align Lex
Type D Language: $\text{NonRec}_{\text{PWd}}$ >> Align Lex >> Exh_{PPh}
Type E Language: Exh_{PPh} >> Align Lex >> $\text{NonRec}_{\text{PWd}}$

They classify English as a Type A language and Makassarese as a Type D language. In English the constraint Align Lex dominates $\text{NonRec}_{\text{PWd}}$ and Exh_{PPh}, consequently clitic plus host combinations exhibit nested structure and some material is allowed to be left unfooted in a PPh.

Let us cite at this point the typology of functional words/clitics postulated in Selkirk (1995). Selkirk (1995) posits no prosodic level of the clitic group and presents four options in the prosodization of function words, quoted here as (23). They may all be realized in one language or may be selected by various languages (option 23c is not selected in English, which has no internal clitics). The abbreviation *fnc* stands for the phonological content of function words, while *lex* represents the phonological content of lexical (major syntactic category) words.

(23) a. $((\text{fnc})_{\text{Pwd}}\ (\text{lex})_{\text{Pwd}})_{\text{PPh}}$	function word as an independent Pword
b. $(\ \text{fnc}\ (\ \text{lex}\ )_{\text{PWd}}\ )_{\text{PPh}}$	function word as a free clitic
c. $(\ (\ \text{fnc lex}\ )_{\text{PWd}}\ )_{\text{PPh}}$	function word as an internal clitic
d. $(\ (\ \text{fnc}\ (\ \text{lex}\ )_{\text{PWd}}\ )_{\text{PWd}}\ )_{\text{PPh}}$	function word as an affixal clitic

The option of leaving some material unfooted in a PPh is realized in English in the case of free clitics, such as non-phrase final monosyllabic function words in the phrases *to go* or *to London.* Free clitics adjoin to PWd at the level of PPh (see 23b); there is no PWd boundary at the beginning/end of such function words. Violation of NonRecPWd is exemplified by affixal clitics, which adjoin to the inner PWd and cause its recursion. Phrase-final reduced weak object pronouns in English, as in the phrases *tell him* or *give them,* are treated in Selkirk (1995) as affixal clitics.

In Makassarese, according to Basri et al. (1998, 1999), $\text{NonRec}_{\text{PWd}}$ is the highest-ranked (undominated) constraint, hence there is no recursion of the PWd node. Makassarese has internal clitics, such as possessive elements *-ku* 'my', *-ta* 'our', *-nu* 'your' and *-na* 'his/her/its/their'. An internal clitic is fully integrated into an adjacent content word: it is dominated by the same prosodic word node as the lexical word which serves as its host (see

23c). The main stress in Makassarese falls upon the penultimate syllable in a PWd. The data in (24) show that the addition of possessive markers shifts the main stress rightwards, which testifies to the lack of a PWd bracket in front of them. Another piece of evidence for an absence of the internal PWd edge is the lack of stem-final mid vowel laxing in (25). The presence of the main stress is marked in (24) by capitalizing the appropriate vowel. Lax vowels in (25) are underlined.

(24)	a.	mejAn-na	'his table'	mEjaŋ	'table'
	b.	ballAk-ku	'my house'	bAllaʔ	'house'
(25)	a.	birallE-ta	'our corn'	birAll<u>e</u>	'corn'
	b.	mEjaŋ lompO-ta	'our big table'	l<u>o</u>mp<u>o</u>	'big'

Exh_{PPh} is ranked in Makassarese below $NonRec_{PWd}$ and Align Lex, which predicts that some syllables will be left unparsed, as demonstrated for the absolutive marker *-aʔ* and the emphatic markers *-mi,-ma* in (26) (where stress assignment indicates that they are external to PWd).

(26)	a.	gAssiŋ	'strong'	gAssiŋ-aʔ	'I am strong'
	b.	bAlli	'buy'	bAlli-ma	'buy, emph'

The data from Makassarese illustrate a problem which is reminiscent of the difficulty encountered with Polish prefixes/proclitics in section 3. While some phonological phenomena (namely stress assignment and stem-final vowel laxing) indicate the lack of internal PWd edges in clitic plus host strings, there exist processes (such as the epenthesis of PWd-final Vʔ) which call for the presence of such a PWd edge. According to Basri et al. (1998) the epenthesis in (27) (and ist absence in 28) may be interpreted as resulting from a prohibition of coda r/l/s and a requirement that a PWd end in a consonant.

(27) *Stem*	*Bare form*		*Host+affixal clitic form*	
a. /oter-/	Othereʔ	'rope'	oterEʔ-nu	'your rope'
b. /rantas-/	rAntasaʔ	'dirty'	mEjaŋ rantasAʔ-na	'his dirty table'

(28) *Stem*	*Bare form*		*Affixed form*	
/rantas/	rAntasaʔ	'dirty'	rantAs-aŋ	'dirtier'

To account for the presence of the VC epenthesis in the host+clitic strings in (27), given the postulated absence of the PWd edge at the locus of epenthesis, Basri et al. (1998, 1999) resort to the use of O(utput)-O(utput) identity constraints (in the spirit of the theory of correspondence put forward in McCarthy and Prince 1995, Benua 1997). They regard the presence of the epenthetic VC sequence in the host plus affixal clitic combinations as a (phonological) 'compositionality effect'. Following the analysis for English in Selkirk (1984), Basri et al (1998, 1999) postulate a distinction between affixation to Stems and affixation to Words in Makassarese morphology. They also propose two families of morphological domain-sensitive O-O faithfulness constraints: O-O_{Word}. and O-O_{Stem} correspondence. The clitic plus host structures exemplified in (27) above involve affixation to Word, hence they exhibit compositionality effects, as predicted by O-O_{Word} correspondence. The faithfulness constraint involved in this case is O-O_{Wd} Max (C) which requires the occurrence of the same segments in two output strings. As is shown in (29), quoted from Basri et al. (1997:17), O-O_{Wd} Max (C) outranks I-O Dep (C). The latter constraint penalizes the presence of epenthetic consonants since it predicts that each element of the output has its correspondent in the input. In contrast, the host+affix structure illustrated in (28) involves O-O_{Stem} correspondence. The constraint O-O_{Stem} Max(C) is ranked lower than O-O_{Wd} Max (C) and I-O Dep (C), hence the absence of the glottal stop:

(29) Base Affiliate

	Base	Affiliate	O-O_{Wd} Max(C)	I-O Dep(C)	O-O_{Stem} Max(C)
Input	$[[\text{rantas}]_{Stem}]_{Word}$	$[[[\text{rantas}]_{Stem}]_{Wd}\ \text{-nu}]_{Wd}$			
Output	$(\text{rAntas}\underline{\text{a}}\text{ʔ})_{PWd}$	⇨a. $(\text{rantas}\underline{\text{A}}\text{ʔnu})_{PWd}$		*	
		b. $(\text{rantas}\underline{\text{A}}\text{nu})_{PWd}$	*!		*

In the next section I will attempt to employ the mechanism of O-O correspondence to account for the behaviour of strings containing prefixes or proclitics in Polish.

5 An account of Polish proclitic plus host sequences

It seems plausible to classify Polish as a Type C Language, in which NonRec_{PWd} and Exh_{PPh} jointly outrank Align Lex (see 22).[22] The high ranking of NonRec_{PWd} would predict the absence of nested structures, and would allow the proclitic/prefix and the initial syllable of a host to form a foot.

Exh_{PPh} is undoubtedly ranked fairly high in Polish, since there is a tendency to incorporate proclitics into their hosts, as in *po oddaniu* 'after returning', i.e. (σσ)(σσ), instead of σσ(σσ). Moreover, in a phrase such as *po ich oddaniu* 'lit. after their retuning (i.e. after the return of them'), a foot is formed by the two monosyllabic function words which precede their host.[23]

[22] I owe this suggestion to Lisa Selkirk.

[23] Peperkamp (1996) uses similar evidence to argue that Exh_{PPh} is ranked high in Neapolitanian

Although normally unstressed, one of the function words carries secondary stress in slow and deliberate speech, hence it can function as the head of a foot.[24] This is illustrated in (30):

(30) a. po ich oddaniu 'lit. after their retuning' (i.e. 'after the return of them')
b. $[(2\ \ 0)\ \ 0\ \ (1\ \ 0)]_{PWd}$
c. $*[0\ \ 0\ \ 0\ \ (1\ \ 0)]_{PWd}$

Align Lex is, thus, ranked fairly low. As a matter of fact, we need to invoke here Align Mword constraint, proposed in Kraska-Szlenk (1995), instead of Align Lex.[25] Let us recall that Mwd include all Lex, i.e. all major category words, as well as polysyllabic minor category words, e.g. polysyllabic prepositions, conjunctions and pronouns.

The difference between the presence of resyllabification and palatal assimilation in stem + suffix strings and the absence of those phonological operations in prefix + stem combinations can be accounted for once we assume that prefixation in Polish involves affixation to Words, while suffixation is affixation to Stems. This assumption bears some resemblance to the proposal put forward in Rubach and Booij (1990), who regard Polish suffixes as Class 1 (cyclic) affixes and prefixes as Class 2 (postcyclic) affixes. Since prefixes are processed phonologically after suffixes, the constituency bracket '[', which indicates a left stem edge, is present at the prefix-stem juncture postcyclically, and it is able to block cyclic phonological processes.[26]

Within the non-derivational model of OT adopted here the constituency brackets cannot be present in the prosodic representations of prefixed words (or proclitic plus host combinations), as was argued in section 1. However, there is a difference between morphosyntactic representations of suffixal derivatives and prefixal derivatives, as given in (31) for the words *poducz* 'to teach (a little), imp(erative)' and *nosem* 'nose, instr.sg': [27]

(31) a. $[\text{pod}\ [[\text{ucz}]_{Stem}]_{Wd}\ ]_{Wd}$
b. $[[\text{nos}]_{Stem}\text{em}]_{Wd}$

[24] The prosodization in (30c) is adequate for representing the stress distribution in fast speech. Rubach and Booij (1985) observe that secondary stresses in Polish disappear gradually with the increase in the tempo of speech.

[25] In other words, we might say that Align Lex is dominated by Align Mword which, in turn, is dominated by Exh_{PPh} and NonRec_{PWd}.

[26] Rubach and Booij (1990) do not assume that phonological and morphological operations are interspersed, which was the predominant view in earlier versions of Lexical Phonology (e.g. in Rubach 1984). They propose, instead, that all morphological derivations precede phonological ones.

[27] Gussmann (1980), Rubach and Booij (1990), or Szpyra (1989) assume that zero inflectional endings, such as the non.sg.masc or the imperative morpheme, should be represented as yers (since they trigger Lower). In contrast, Szpyra (1992a) argues against such an analysis, pointing out that there is no evidence for the phonetic content of such 'zero endings'. Consequently, in the structures given in (31) and the tableaux shown in (32-33) the putative zero inflectional endings are not marked.

Basri et al. (1998, 1999) argue that affixation to Word in Makassarese involves syntactic adjunction. Some morphosyntactic evidence can be adduced in Polish to support the treatment of prefixes as syntactically adjoined to their verbal bases (hence analyzed as attaching to Words and bracketed 'outside' suffixes). Walińska (1989) proposes that Polish prefixes occupy a higher position in the VP (verb phrase) than inflectional endings. They are inserted either into the Specifier of VP or Specifier of V'. Consequently, they have influence on case assignment within VP. For instance, the accumulative prefix *na-* requires the direct object to be in a partitive genitive case, as in the phrase *nazbierać grzybów* 'to gather (a lot of) mushrooms'. In a similar vein, Slabakova (1998) analyzes all Slavic prefixes as preverbs, which are heads of upper V (i.e. they are higher than the lexical verb stems), hence they take scope over the direct object.

The representations in (31) are visible as input to correspondence constraints which evaluate the phonological affinity between the derivative and its morphological base. As in Makassarese, we can propose that the lack of faithfulness effects in Polish words containing affixes attaching to Stems result from the low ranking of O-O_{Stem} correspondence constraints. As illustrated in (32) below, O-O_{Stem} Ident-Syll is outranked by ONSET, i.e. the constraint which requires that a syllable not start with a vowel.

(32) nos 'nose.nom.sg',
nosem 'nose, instr.sg'

	Base	Affiliate	O-O_{Wd} Ident-Syll	ONSET	O-O_{Stem} Ident-Syll
Input Output	$[[\text{nos}]_{\text{Stem}}]_{\text{Word}}$	$[[\text{nos}]_{\text{Stem}}\text{em}]_{\text{Wd}}$			
	$(\text{nos.})_{\text{PWd}}$	⇨a. $(\text{no.sem})_{\text{PWd}}$			*
		b. $(\text{nos.em})_{\text{PWd}}$		*!	

The absence of trans-junctural resyllabification in the prefixed verb in (33) can be accounted for by employing O-O_{Word} Ident-Syll[28], which dominates ONSET and O-O_{Stem} correspondence constraint. Let us emphasize once again that, although there is no PWd edge in front of the stem in *poducz* 'to teach (a little), imp.', phonological effects parallel to those stemming from the presence of a PWd boundary result from the application of O-O_{Word} constraints.

[28] The constraint in question is given the following formulation in Basri et al. (1998:11): 'The syllable structure of instances of £ in a word-based paradigm must be identical.' (Where £ is the base of the paradigm and £' is the derivative/affiliate in the paradigm.)

(33) ucz 'teach, imp.',
poducz 'teach (a little), imp.'

	Base	Affiliate			
Input Output	$[[ucz]_{Stem}]_{Word}$	$[pod\ [[ucz]_{Stem}]_{Wd}\ ]_{Wd}$	O-O_{Wd} Ident-Syll	ONSET	O-O_{Stem} Ident-Syll
	$(ucz)_{PWd}$	⇨a. $(pod.ucz)_{PWd}$		*	
		b. $(po.ducz)_{PWd}$	*!		

A potential problem that arises with regard to the analyses proposed here is what counts as a possible affiliate and a base. Do they need to be derivationally related? Basri et al. (1998) follow Benua (1997) and McCarthy and Prince (1995) in asserting that O-O correspondence relations hold only between strings which are dominated by morphosyntactically identical constituents appearing in the same paradigm. One of such paradigms is the word-based paradigm, defined in Basri et al (1998) as in (34):

(34) Def: '*A word-based paradigm* consists of a pair of lexical category words {£,£'}, where £ = $[lex]_{£}$ and £' = $[\ [lex\ ]_{£}\ £\ \alpha\ ]_{£'}$, £ an immediate constituent of £'.
The nonembedded instance of £ is the *base* of the paradigm, £ is the *derivative* in the paradigm.'

In order to allow for output-output correspondence constraints to operate on proclitic and lexical word combinations (e.g. *pod nosem* 'below the/an nose') and to match them with the corresponding non-procliticized forms (e.g. *nosem* 'eye, instr.sg'), it is necessary to assume, following Kenstowicz (1996) and Kraska-Szlenk (1995), that there is a host-based paradigm. It includes the base (the phonological host) and the affiliate (i.e. a string consisting of the host and a clitic or clitics).[29]

6 Possible extension of the analysis to host-plus-enclitic sequences

Once we have postulated (on the basis of the data from the the proclitic plus host strings) the occurrence of O-O constraints and assumed that $NonRec_{PWd}$ dominates Align Lex in Polish, it is possible to postulate that there is no PWd edge between the host and enclitic. Consequently, the phrase consisting of a proclitic followed by a host and an enclitic is one PWd. The

[29] A similar position seems to be taken recently in McCarthy (2000:187), where it is tentatively suggested that Output-Output correspondence relates various realizations of a word depending on its phonosyntactic context (including contextual or pausal forms of such a word).

placement of the main stress on the penultimate syllable of the host (with disregard of the enclitics) can be predicted in one of two ways:

I. There can be recourse taken to O-O_{Word} Faith, to make sure that the placement of the primary stress in the host is the same as in the host+enclitic sequence (i.e. 'no stress shifting' effect in host+enclitic sequences in Polish would receive a similar explanation to the account of the lack of stress shift in English words containing stress-neutral (Class II) affixes proposed in Benua 1997).[30]

II. We can postulate a high-ranked constraint aligning the right edge of the Head Foot with the right edge of a Mword.[31] This, in combination with the other constraints given in the tableau in (36), [32] would predict the prosodic structure in (36a) as the winning candidate:

(35) po oddaniu ich
after returning, pf.loc. them.gen

(36) Input
po [oddaniu]$_{Mwd}$ ich

	Al-R (HdFt,Mwd)	Al-L (PWd,Ft)	Base-Id	Parse-σ	Al-L (Ft,PWd)
☞a. [(2 0) (1 0) 0]$_{PWd}$				*	2*
b.[0 0 (1 0) 0]$_{PWd}$		**!		***	2*
c.[0 (2 0)(1 0)]$_{PWd}$	*!	*	***	*	4*
d.[0 (1 0)(2 0)]$_{PWd}$	*!	*	***	*	4*

Base: oddaniu
0 (1 0)

The facts from segmental phonology in the host plus enclitic combinations would, then, be accounted for by some additional O-O constraints. For instance, the lack of resyllabification

[30] Benua (1997) proposes that stress shifting (Class I) and stress neutral (Class II) affixes subcategorize for different Output-Output correspondence relations between the base and the affiliate (the derivative), namely OO_1 and OO_2-Correspondence. OO_2-Faithfulness is ranked above Markedness constraints which trigger the regular stress pattern (in non-derived words). This ranking results in the preservation of base prosody in derivatives with Class II suffixes. OO_1-Faithfulness, in contrast, is ranked below other stress constraints.

[31] This constraint, dubbed Al-R(HdFt, Mwd) in (36), bears superficial similarity to constraints aligning the right edge of the head foot with the right edge of some prosodic word, e.g. MainRight in Parker (1997).

[32] The constraint abbreviated as Base-Id in (35) is Base Identity (given in 8b). Al-L(Ft,PWd) is mentioned in footnotes 3 and 8. It predicts that the left edge of each foot should coincide with the left edge of some prosodic word. The constraint Al-L(PWd,Ft), in turn, requires that each prosodic word aligns its left edge with the edge of some foot.

or word-final devoicing observable before an enclitic could be regarded as a compositionality effect.

7 Conclusions

The present paper analysed the prosodization of proclitics in Polish, focusing on prepositions and prefixes. I pointed out the incompatibility of earlier analyses of proclitic plus host (or prefix plus stem) combinations with the non-derivational framework of Optimality Theory. The analyses of sequences consisting of a prefix and a stem, or a proclitic and its host, outlined in, among others, Rubach and Booij (1985, 1990) assume that there is a PWd edge in front of the host. Distribution of secondary (rhythmic) stresses in such strings shows, however, that the proclitic and the initial syllable of a host form a foot, which would run across a presumed PWd boundary (in violation of the Prosodic Hierarchy).

Following the analysis of Makassarese in Basri et al. (1998, 1999), I have assumed that the rankings of Lex-PWd Alignment constraints and constraints on prosodic domination (namely, Exhaustivity$_{\mathrm{PPh}}$ and Nonrecursitivity$_{\mathrm{PWd}}$) are responsible for typological differences between languages. In Polish NonRec$_{\mathrm{PWd}}$ and Exh$_{\mathrm{PPh}}$ outrank Align Lex, hence the combinations of proclitics and hosts, or prefixes and stems, exhibit no nested structure.

In order to account for the facts from segmental phonology, which appear to indicate the need for a strong juncture following the proclitic (or the prefix), I proposed that such (phonological) 'compositionality' effects are achieved by employing O(utput)-O(utput) constraints. They compare the phonological shape of the host and the string consisting of the host and clitic(s) attached to it.

It was tentatively suggested that such an analysis can be extended to host+enclitic combinations, which can similarly be interpreted as containing no recursion of the prosodic word node.

I emphasized two points in which the analysis offered in Basri et al. (1998, 1999) must be modified when applied to Polish. Firstly, instead of employing Align Lex, we need to refer to Align Mwd. Secondly, while for Basri et al. (1998, 1999) the relationship between the base and the affiliate is that between a (morphological) base and its derivative, in Polish (following Kraska-Szlenk 1995 and Kenstowicz 1996) we need to postulate O-O constraints that can compare the shape of the host and the clitic plus host strings.

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Satisfying minimality in Ndebele*

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1 Introduction

Work on minimality (McCarthy & Prince 1986, 1993a; Crowhurst 1992; etc.) has mainly focussed on two types of morphological constituents, Word and RED. Little work has explored the role of minimality in constraining other morpho-prosodic domains or the variety of strategies a single language might use to satisfy minimality in different morphological contexts. In this paper, I discuss four different verb forms in Ndebele (a Nguni Bantu language spoken mainly in Zimbabwe) – the imperative, reduplicated, future and participial. I show that while all four are subject to minimality restrictions, minimality is satisfied differently in each of these morphological contexts. To account for this, I argue that in Ndebele (as in other Bantu languages) Word and RED are not the only constituents which must satisfy minimality: the Stem is also subject to minimality conditions in some morphological contexts. This paper, then, provides additional arguments for the proposal that Phonological Word is not the only sub-lexical morpho-prosodic constituent. Further, I argue that, although Word, RED and Stem are all subject to the same minimality constraint – they must all be minimally bisyllabic – this does not follow from a single 'generalized' constraint. Instead, I argue, *contra* recent work within Generalized Template Theory (see, e.g., McCarthy & Prince 1994, 1995a, 1999; Urbanczyk 1995, 1996; and Walker 2000; etc.) that a distinct minimality constraint must be formalized for each of these morpho-prosodic constituents.

2 Background

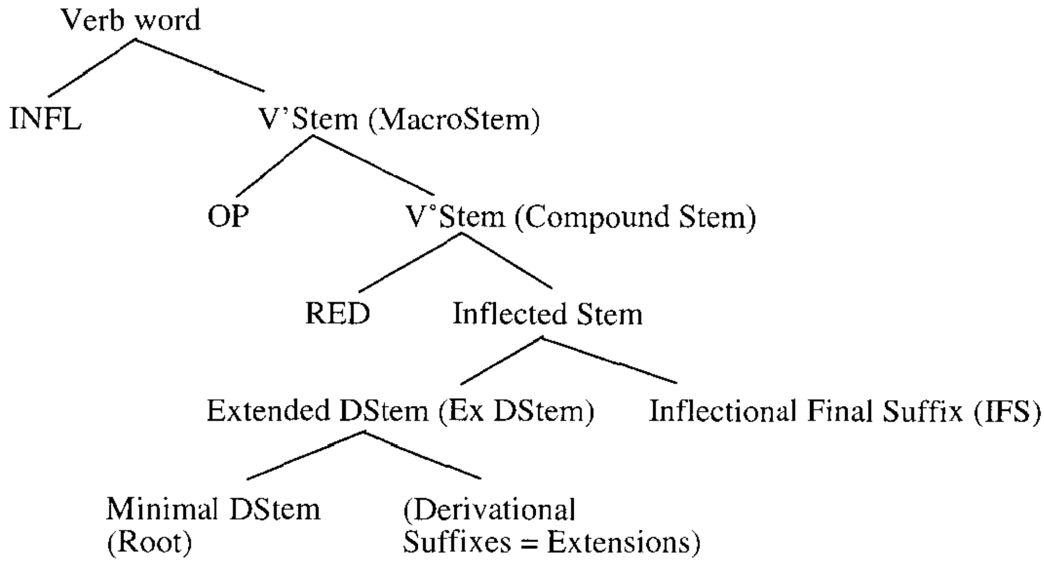
2.1 Bantu verb structure

As background to the analyses presented below, it is important to note that I am assuming the verb word structure shown in (1). This structure has been argued for for other Bantu languages in work by Barrett-Keach (1986), Hyman (1993), Hyman & Mtenje (1999), Mchombo (1993), Myers (1987, 1998) and Mutaka (1994), among others, who show there is both phonological and morphological evidence that Bantu verb words consist of two distinct constituents: the inflectional prefixes (INFL) and the Stem (Inflected Stem). (This is also the traditional view of Bantu verb structure presented in work like that of Doke (1943, 1954) and Meeussen (1967).) Subject prefixes (SP) and tense/aspect prefixes are daughters of INFL. Stems consist minimally of the Root (or Minimal D(erivational) Stem) and an Inflectional

* This research was supported in part by NSF POWRE grant #SBR-9806180, and an International Research supplement to this grant. The International Grant allowed me to spend May-July 2000 at the University of Zimbabwe, Harare, where I collected most of the data cited in this paper. My thanks to the Departments of Linguistics and of African Languages at the University of Zimbabwe, and in particular to Francis Matambirofa and Carolyn Harford, for their hospitality during my stay. I owe special thanks to Thulani Dube, a graduate student at the University of Zimbabwe and native speaker of Ndebele, for his patience and insight in helping me learn about his language. Any errors of fact or interpretation in this paper are my responsibility.

Final Suffix (IFS), separated by optional derivational suffixes (or extensions). As shown, the object prefixes (OP) and RED are often arguably dependents of a larger MacroStem constituent. In this paper, the terms „Stem" and „MStem" are used interchangeably to refer to the constituent labelled „Inflected Stem" in the structure in (1).

(1) The representation of verb words in Bantu (adapted Myers 1987; Hyman & Mtenje 1999)



2.2. Morpho-prosodic domains

The analyses presented below assume that phonological processes only take morpho-prosodic constituents as their domains. As Inkelas (1989, 1993) argues, this assumption follows if we take seriously Selkirk's (1986) proposal that all phonological rules apply within morpho-prosodic domains, rather than domains defined directly on morpho-syntactic structure. This is because, in prosodic domains theory, neither sub-lexical morphological constituents nor super-lexical morpho-syntactic ones directly define the domain for phonological rules. Instead, every morphological constituent (M-constituent) which serves as a domain for phonological or prosodic rules must have a corresponding morpho-prosodic constituent (Ph-constituent), and it is this Ph-constituent which interacts with the phonology. In the default case, the Ph-constituent is coextensive with the corresponding M-constituent. However, the two may be misaligned, for example, to improve the prosodic well-formedness of the Ph-constituent as in the analyses argued for below. Following work like that of Czaykowska-Higgins (1996, 1998), Downing (1999b) and Inkelas (1989, 1993), I assume that sublexical morphological constituents like Stem and Root have corresponding Ph-constituents. Evidence for a distinction between PhWord and PhStem in Ndebele will be presented in section 5, below.

2.3 Phonological background

All of the Ndebele data is cited in the orthography (except where clearly indicated otherwise). It is important to note that all consonant sequences in Ndebele orthography are phonetically single sounds - eg., 'kh' = [k^h]; 'hl' = [•]; 'dl' = [•]; mb= [^{m}b]; etc. - and syllable structure is strictly (C)V. Also, in Ndebele orthography 'y' is the palatal glide; 'j' is a palatal affricate and 'c', 'q', 'x' are the dental, retroflex and lateral clicks, respectively. Note that acute accents indicate high tone (unaccented vowels have a low tone) in the data below, while a colon following a vowel indicates length. (As will be discussed in more detail below, penultimate syllables are always lengthened.)

3 Imperatives

Work like Brandon (1975), Herman (1995), Mutaka (1994) and Myers (1987, 1995) has established the importance of PhWord as a phonological domain in many Bantu languages. The motivation for the PhWord as a constituent in much of this work comes from examining the imperative form of verb stems, since the imperative is the only context where verb stems may occur unprefixed in most Bantu languages. As shown in (2a), Ndebele follows this general pattern: the imperative form of most verbs consists of the bare verb stem. But in (2b) we see that monosyllabic stems are augmented by epenthesizing a syllable in the imperative. And in (2c) we see that vowel-initial stems are (optionally) augmented by epenthesizing an onset in the imperative.

(2) Imperative verbs in Ndebele (Downing field notes; Rycroft (1983); source of the H tone is underlined; '=' indicates the INFL=MacroStem juncture)

	Infinitive	Imperative	Gloss
(a) *Multisyllabic,*			
C-initial	úkú=do:nsa	do:nsa	to pull
	úkú=bhukú:tsha	bhukú:tsha	to swim
	úkú=khi:pha	khi:pha	to put out
	úkú=búthéle:la	buthelé:la	to heap up
(b) *Monosyllabic*			
	úkú:=lwa	yí:-lwa	to fight
	úku:=phá	yi:-phá	to give
	úku:-zwá	yí:-zwa	to hear
	úkú:=fa	yi:-fa	to die
(c) *V-initial*			
	úkw=á:la	y-á:la	to refuse
	úkw=éla:pha	y-elá:pha	to cure
	úkw=éthú:la	y-ethú:la	to go down
	úkw=ábi:sa	y-abí:sa	to help divide

Epenthesis in the vowel-initial stems can be motivated by the requirement that imperative forms must be prosodically optimal by satisfying the Onset Principle (Itô 1986; Downing

1998a,b). As argued by Myers (1987) for Shona, another Bantu language, the best motivation for syllable epenthesis in the imperative form of monosyllabic stems is that, cross-linguistically, PhWords are required to be minimally bisyllabic. As work like McCarthy & Prince (1986, 1994, 1995b) and Selkirk (1995) has argued, this follows from the prosodic hierarchy. PhWord dominates Foot in the hierarchy, so by the Headedness Principle of the Strict Layer Hypothesis (Selkirk 1984, 1995; Nespor & Vogel 1986), PhWord must dominate a Foot. Since Feet are minimally bisyllabic then PhWords must be, too. As we can see in the data in (2), Ndebele words are, in fact, stressed on the penultimate syllable (this is indicated by lengthening the penult vowel), as is typical in Southern Bantu languages (Doke 1954; Myers 1987). It is plausible, then, to propose that in Ndebele, too, the minimality requirement on PhWords falls out from a requirement that they dominate a bisyllabic foot. The minimality and Onset conditions on PhWord can be formalized by the following constraints:

(3) (a) **Headedness** (adapted Selkirk 1995, fig (4ii)): A PhWord must dominate a metrical Foot.[1]
(b) **FtMin:** Feet are minimally bisyllabic.
(c) **Onset:** *AlignL(σ, μ_s)
OUTRANK
(d) **PhWord≈MWord:** PhWord is coextensive with MWord
(e) **DEP-IO**: Output segments must have input correspondents.

These constraints and ranking optimize misaligning the MWord (in this case the bare verb stem) with PhWord by epenthesis in order to satisfy minimality and Onset. The analysis is exemplified in (4).[2] Note that in this tableau, '[' indicates a PhWord edge; '(' indicates a foot parse, and '{' indicates an MWord edge:

[1] By metrical foot, I mean a foot that has a head which is more prominent than the other elements of the foot (through stress, length, pitch).
[2] To complete the analysis, one must explain why [yi] is the epenthesized syllable, rather than some other. It is actually not surprising that [yi] should be epenthesized since [i] is a common epenthetic vowel, probably due to its inherent shortness and resulting inherent lack of sonority (Steriade 1995; Pulleyblank 1998). This generalization can be formalized, following Pulleyblank (1998), by a harmonic ranking placing DEP[+hi,-back] below other featural faithfulness constraints. To account for why only a single trochaic foot is parsed at the right edge of the word in Ndebele, I propose that **AllFtR** (a constraint requiring all feet to be aligned at the right edge of the word) outranks **Parse σ** (a constraint requiring all syllables to be parsed into feet). Since none of these constraints are ever violated, they will not be included in the tableaux.

(4)

	Headedness	FtMin	Onset	PhWord≈MWord	DEP-IO
/donsa/					
√(a) [({do:nsa})]					
* (b) [YI{(do:nsa})]				*!	**
/lwa/					
√ (c) [(YI:{lwa})]				*	**
* (d) [({lwa})]		*!			
/ala/					
√ (e) [(Y{a:la})]				*	*
* (f) [({a:la})]			*!		

As shown in this tableau, it is not optimal to misalign MWord and PWord by epenthesis when MWord satisfies prosodic well-formedness (compare (4a) with (4b)). However, when MWord is subminimal (as in (4d)) or lacks an onset (as in (4g), it is optimal to misalign MWord and PWord by epenthesizing enough material to satisfy prosodic wellformedness constraints, but no more (as shown in (4h)).

To sum up this section, imperatives provide our first evidence that morpho-prosodic constituents in Ndebele are subject to a bisyllabic minimality constraint. Imperatives are arguably PhWords. Since PhWord is the domain for stress assignment in Ndebele, the minimality requirement on imperatives falls out from the requirement that PhWord dominate a stress foot. For comparison with cases to be discussed later, it is also important to note that epenthesis of phonologically unmarked material before the morphological base is the strategy used to satisfy minimality in the imperative.

4 Reduplication

In Ndebele, as in many other Bantu languages (see Downing 2000 and references cited therein), verb stems can be reduplicated to indicate that the action of the verb is done for a short period of time or in a careless fashion. As shown by the data in (5a), RED is maximally bisyllabic: no matter how long the Base verb stem is, RED never exceeds two syllables. The data in (5b) shows that RED is also minimally bisyllabic. Monosyllabic stems are augmented by [yi], just as in the imperatives. The only difference is that [yi] follows the RED segments corresponding to the Base stem, while in the imperative [yi] preceded the segments corresponding to the input stem.[3] The vowel-initial stems in (5c) show that minimality in the RED is achieved by epenthesizing [y] between the RED and the Base.

[3] Evidence that the /yi/ is epenthesized into RED, not the Base stem, comes from the fact that /yi/ appears in RED even when the Base contains suffixes making it longer than monosyllabic: e.g., si=dl-íle 'we ate' reduplicates si=**dlayi**-dlíle. I assume high-ranked AnchorL-BR accounts for the position of the epenthesized material.

(5)Ndebele reduplication (Downing field notes; RED is bolded; source of the H tone is underlined; '=' indicates the INFL=MacroStem juncture)[4]

	Infinitive	Reduplicated	Gloss
(a) *Multisyllabic, C-initial*	úkú=do:nsa	úkú=**donsá**-do:nsa	to pull
	úkú=há:mba	úkú=**hamba**-há:mba	to go
	úkú=hambí:sa	úkú=**hambi**-hambí:sa	to cause to go
	úkú=khanzí:nga	úkú=**khanzi**-khanzí:nga	to fry
	úkú=límísa:na	úkú=**límí**-límísa:na	to help ea. other farm
(b) *Monosyllabic*			
	úkú:=lwa	úkú=**lwáyí**:-lwa	to fight
	úku:=dla	úkú=**dlayí**:-dla	to eat
	úku:=zwá	úkú=**zwayí**:-zwa	to hear
	úkú:=za	úkú=**zayí**:-za	to come
	úkú:=fa	úkú=**fáyi**:-fa	to die
(c) *V-initial*			
	úkw=á:ba	úkw=**ábá**-y-a:ba	to divide up
	úkw=énzi:sa	úkw=**énzi**-y-énzi:sa	to cause to do
	úkw=á:kha	úkw=**ákhá**-y-a:kha	to build
	úkw=éndla:la	úkw=**éndla**-y-éndla:la	to spread

Since REDs, like imperatives, are minimally bisyllabic and minimality is satisfied in the same way for REDs and imperatives, one might assume that they are also PhWords. If this were so, then the minimality condition on REDs could also fall out from the requirement that PhWords must dominate stress feet. However, there a two important arguments why REDs are not PhWords. The first is that, if RED were a separate PhWord, we would expect its penult vowel to be lengthened under stress. However, as is clear from the data in (5), REDs are not assigned stress. Only the penult vowel of the entire reduplicated form (INFL=RED+Base stem) is lengthened, showing that both RED and the Base stem are contained within a single PhWord to which stress is assigned. Another argument comes from the tone pattern of the reduplicated forms. In Ndebele, as in other Nguni languages (see Downing 1990, 1996; Rycroft 1980, 1983 and references cited therein), high tones shift rightwards. The rightmost high tone generally surfaces on the antepenult of the word, even if the syllable which contributes the high tone is several syllables to the left of the antepenult and must cross a MacroStem boundary to reach the antepenult. This is illustrated in (5) where we see the H tone from the infinitive prefix úku- regularly spreads rightward into RED and the Base stem. More examples of low-toned verb stems following other H-toned prefixes (underlined) are given in (6). Note that ya- is the present affirmative focus prefix and –ile is the past tense suffix; both are underlyingly low-toned:

[4] See Hyman, Inkelas & Sibanda (1999) for discussion of reduplication in a different dialect of Ndebele.

(6) (a) ú̲-yá=vódlo:za 's/he is crushing'
(b) bá̲-yá=tshéle:la 'they are slipping'
(c) bá̲=lím-i:le 'they farmed'
(d) ú̲-yá=búthéle:la 's/he is heaping up'
(e) bá̲-yá=phéfúmu:la 'they are breathing'

Notice in this data that the prefixal H tone crosses the morphological stem boundary (=) to reach the antepenult when the stem has no H tone.

However, as shown in the data in (7), H tones do not shift long distance across word boundaries. In this data (taken from Rycroft (1983)), notice that H tones of the first word do not spread to the following word even when it is all low-toned:

(7) akú:kho bantwa:na 'there are no children'
akú:kho zikhwa:ma 'there are no bags'
akú:kho ndlwanya:na 'there is no small house'
ábáfá:na be:thu 'our boys'
ízi:nto za:khe 'his/her things'

I conclude from this that long distance tone spread is word-bound. In terms of the theory adopted here, that means it takes PhWord as its domain. Since H tones clearly shift to RED and its Base from the preceding prefixes, as shown in (5) and (6), they must be within the same PhWord as the prefixes and cannot be separate PhWords themselves.

Since RED is not a PhWord, then the minimality restriction on REDs cannot follow from the same general constraints on stress footing defining PhWord minimality that applied in the imperative. Instead, I propose that RED minimality is accounted for by the constraints in (8):

(8)(a) **RED=Ft**

i. The RED string is coextensive with a foot.

ii. The RED string is associated with the weight-bearing elements of a foot.

(b) **FtBin**

i. FtMin: Feet are minimally bisyllabic

ii. FtMax: Feet are maximally bisyllabic.

(c) **SMAX-BR**: Every segment of the Base (B) has a correspondent in the RED (R).

Ranking: RED=Ft, FtBin >> SMAX-BR, DEP-IO

Note that the Foot defining the RED size cannot be a metrical foot, unlike the foot defining the minimal PhWord, since RED is not stressed. Instead, the foot in (8a) is a purely prosodic, non-headed foot, parsing the RED string into a binary constituent.[5]

The analysis is examplified in (9). Note that parentheses indicate the prosodic foot parse; RED is bolded:

(9)

	RED=Ft	FtMin, FtMax	Onset	SMAX-BR	DEP-IO
/RED-hambisa/					
√(a) (**hambi**)-hambi:sa				**	
* (b) (**hambisa**)-hambi:sa		*! (Max)			
/RED-lwa/					
√ (c) (**lwaYI**:)-lwa					**
* (d) (**lwa:**)-lwa		*! (Min)			
/RED-enzisa/					
√ (e) (**enzi**)-Y-enzi:sa				**	*
* (f) (**enzi**)-enzi:sa			*!	**	
* (g) (**enzi**)s-enzi:sa	*!			*	

As shown in (9a), it is optimal to partially reduplicate longer Base stems in order to satisfy FtMax. It is also optimal to augment monosyllabic Base stems by epenthesis, as shown in (9c), to satisfy FtMin. And, as shown in (4e), epenthesizing /y/ is optimal in V-initial stems as it allows RED to be aligned with a foot while satisfying Onset.

To sum up this section, while REDs, like PhWords, are minimally bisyllabic, this condition cannot be accounted for by parsing REDs as PhWords. The lack of stress on REDs and their ability to be a target for prefixal H tones shows that they are not separate PhWords, but rather subconstituents of the PhWord containing the prefixes and following Base stem. In the next section, we will see that two other morphological verb forms, the future and participial, are subject to a bisyllabic minimality condition on their output base. However, in these cases, morphology, not phonology, determines the form of the segments which occur to satisfy minimality. Further, we shall see that in the participial, as in RED, the minimality requirement on the base cannot be accounted for by defining the base as PhWord.

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[5] See Downing (2000) for detailed arguments in favor of this approach. Crowhurst (1992) and Mutaka & Hyman (1990) present other arguments for distinguishing prosodic feet (like those used to define RED size) from stress feet, showing that minimality effects cannot always be derived from independently motivated footing in other languages.

The analysis given here does not explain why the epenthentic /y/ that separates the RED and the Base of V-initial stems is not copied, as predicted by work like that of McCarthy & Prince (1993a). Downing (1998b) accounts for this by proposing that the RED in these words corresponds to the input base, not the output (by high ranking DEP-IR). This problem becomes moot in Pulleyblank's (to appear) approach which eliminates BR correspondence in favor of IR correspondence.

5 Future and participial

As shown in (10a), the future prefix in Ndebele is –za-. The data in (10b, c) shows that when monosyllabic verbs and V-initial stems occur in the future tense, they are augmented by /ku/ (which alternates with [k^w] before non-round vowels and [k] before round vowels). However, /ku/ does not occur with these same verb stems if they are preceded by an object prefix (OP), as shown in (10d).[6]

(10)	Future verb forms in Ndebele (Downing field notes)	
(a)	*Multisyllabic, C-initial*	
	si:-za=thí:ya	'we will fish'
	bá:-za=phendu:lwa	'they are being turned around'
	bá:-za=tshele:la	'they will slip'
	si:-za=khanzí:nga	'we will fry'
(b)	*Monosyllabic*	
	si:-za=ku:-lwa	'we will fight'
	bá:-za=ku:-zwa	'they will hear'
	ba:-za=ku:-pha	'they will give'
(c)	*V-initial*	
	si:-za=kw-ehli:sa	'we will bring down'
	bá:-za=kw-e:qa	'they will jump'
	bá:-za=kw-a:kha	'they will build'
	ngi:-za=k-o:ndla	'I will raise; rear
	bá:-za=kw-abela:na	'they will divide for each other'
(d)	*Monosyllabic and V-initial + OP*	
	bá:-za=m-éqi:sa	'they will make him/her jump'
	si:-za=m-esabí:sa	'we will frighten him/her'
	si:-za=bá:-pha	'we will give them'

A similar pattern of alternations is found in the participial form of the verb, used, for example in subordinate clauses introduced by the complementizer úmá 'if'. As shown in (11a), there is no independent tense/aspect marker in this form of the verb. What makes the participial INFL distinctive is that some of the subject prefixes (bé- 'they'; é- 's/he') are different from those used in other affirmative tenses (bá- 'they'; ú- 's/he'). The data in (11b,c) shows that when monosyllabic and V-initial stems occur in the participial, they are augmented by [s(i)]. However, [s(i)] does not occur with these same verb stems if they are preceded by an object prefix (OP), as shown in (11d).

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[6] An identical alternation pattern in the future tense has been identified in Kirundi, a Bantu language spoken mainly in Burundi. See Aronoff (1988), Downing (1998b), Goldsmith & Sabimana (1986), and Myers (1998) for discussion. And see Cassimjee (1999) for discussion of the participial in Xhosa.

(11) Participial verb forms in Ndebele (Downing field notes)

(a) *Multisyllabic, C-initial*

é=qá:nsa	'…s/he is climbing…'	**é=qansá**-qa:nsa	'reduplicated'
é=ngení:sa	'…s/he is putting in…'		
be=bóna	'…they see…'		
be=líma	'…they are farming…'		

(b) *Monosyllabic*

bé=si:-dla	'…they are eating…'
ngi=si:-pha	'…I am giving…'
ngi=sí:-wa	'…I am falling…'

(c) *V-initial*

be=s-éhli:sa	'…they are bringing someone down'
be=s-**éhlí**-y-éhli:sa	reduplicated form of 'they are bringing s.o. down'
e=s-á:kha	'…s/he is building…'
u=s-o:ma	'…you are thirsty…'

(d) *Monosyllabic and V-initial + OP*

e=b-akhé:la	'…s/he is building for them…'
ngi=kú:-pha	'…I am giving you…'

Since /ku/ and [s(i)] only surface with monosyllabic and V-initial MacroStems, their occurrence clearly has a prosodic motivation: they allow these MacroStems to be bisyllabic and begin with onsets. What is less clear is their morpho-syntactic status, since these strings are empty morphs with no identifiable morpho-syntactic function.[7] As their occurrence correlates with particular tense/aspects (future or participial), they are arguably daughters of INFL. However, since they cannot co-occur with OPs and occur in order to satisfy prosodic well-formedness constraints on the MacroStem, they are just as plausibly daughters of the MacroStem. To resolve this ambiguity, I propose that [ku~ k^w] and [s(i)] are morpho-syntactically unaffiliated (and so unpositioned in the input). Their surface position and morpho-prosodic parse are determined solely by constraint interaction.[8] The fact that these empty morphs co-occur with a particular tense/aspect can be formalized by the alignment constraints in (12) requiring the empty morphs to be left-aligned with the right edge of the relevant INFL:

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[7] While/ku-/ resembles the infinitive prefix (and historically, the future may well be derived from the verb 'to come' plus an infinitive complement (Nurse & Muzale 1999), synchronically, the future tense forms cited in (10) are single verb words. That /ku/ is distinct from the infinitive prefix can be seen from comparing the data in (10) with true infinitival complements, where /úku-/ is obligatorily present no matter how long the verb is and whether or not the verb has an OP: e.g., si:-za=za:ma úkú=ba-lwí:sa 'we will try to fight them'. Notice the infinitival complement has an OP (bá- 'them') and the stem itself (-lwisa 'cause to fight') is bisyllabic, yet /úku-/ obligatorily occurs on the verb.

[8] See Booij & Lieber (1993) and Downing (1998b) for discussion and analysis of other cases of prosodically positioned morphemes, and reference to other work on this topic.

(12)(a) **Align /ku/**: Align (L, /ku/; R, Future INFL)
Align the left edge of /ku/ with the right edge of the Future INFL constituent.
(b) **Align /si/**: Align (L, /si/; R, Participial INFL)
Align the left edge of /si/ with the right edge of the Participial INFL constituent.

In order to formalize the constraints expressing the prosodic motivation for the occurrence of these empty morphs, we must first determine which morpho-prosodic constituent they are parsed into. Looking first at the future data in (10), we can see that /ku/ arguably begins a distinct PhWord from the preceding Future INFL, so that the words in (10b,c) have the following morpho-prosodic constituency:

(13)(a) [bá:za]$_{PhWd}$[ku:pha]$_{PhWd}$	'they will give'
[bá:za]$_{PhWd}$[kwa:kha]$_{PhWd}$	'they will build'
[bá:za]$_{PhWd}$[tshele:la]$_{PhWd}$	'they will slip'

Evidence that INFL and and the MacroStem are distinct PhWords comes from the two tests for PhWord-hood discussed in the preceding sections. Notice, first, that the penult vowel of both the INFL and the MacroStem are lengthened, as we expect if they are distinct PhWords. Further, notice that the H tone of the SP bá- 'they' does not spread rightwards to the MacroStem. This tone pattern is expected if the INFL and MacroStem are distinct PhWords; it is totally unexpected otherwise.

These same tests show that /si/ does not begin a distinct PhWord from the preceding Participial INFL. Notice in (11) that only a single vowel in the participial verb word is lengthened: the penult V of the MacroStem. Further, the H tone of the SP spreads to the MacroStem. This is expected if the MacroStem and INFL are part of the same PhWord, but totally unexpected if they are distinct PhWords. Finally, notice the participial INFL consists of a single syllable, and so is too short to constitute a distinct PhWord. I propose instead that /si/ is parsed into PhStem, a morpho-prosodic constituent based on the MacroStem but not necessarily coextensive with it. Since PhStem is a subconstituent of PhWord, it correctly is contained within the same tone and stress assignment domain as the Participial INFL.

PhStem must further be subject to a minimality constraint particular to that constituent:

(14) **PhStem Min:** PhStem is minimally bisyllabic.

PhStem minimality cannot fall out from Headedness (3a), since only PhWords, not PhStems, are required to dominate metrical feet. Further, PhStem, unlike RED and PhWord, is only required to satisfy minimality in certain morphological contexts, like the Participial. Monosyllabic and V-initial MacroStems occur unaugmented in other morphological contexts, like the infinitive (see (5), (6), above) and the -ya- tense in the data in (15), below. (Notice that the stress falls outside the MacroStem in the monosyllabic examples.)

(15) (a) *Monosyllabic*

si-ya:=lwa	'we are fighting'
kú̲-ya:=tsha	'it is burning'
bá̲-ya:=dla	'they are eating'
si-ya:=pha	'we are giving'

(b) *V-initial*

si-y=e:hla	'we are going down'
si-y=a:kha	'we are building'
bá̲-yá=m-éhli:sa	'they are making him/her go down'
si-y=o:tha	'we are basking'

(c) *Multisyllabic, C-initial*

si-ya=khwé̲:la	'we are climbing'
si-ya=nge̲ní:sa	'we are putting in'
bá̲-yá=do:nsa	'they are pulling'

As these data show, no material is ever epenthesized to prosodically improve the MacroStem. This means that the constraint on PhStem minimality must rank below DEP-IO, while the other minimality constraints must rank about DEP-IO, since epenthesis is optimal to satisfy minimality in the imperative and RED. Note that this would create a ranking paradox if PhStem minimality were accounted for with the same constraints appealed to for PhWord and RED minimality.

The empty morphs /ku/ and /si/ surface, then, to satisfy minimality conditions on PhWord and PhStem, respectively. To explain why there is a correlation between the form of the base stem and the occurrence of the empty morphs, I propose that the Future and Participial INFLs must be constrained to affix only to prosodically well-formed bases, PhWord and PhStem. This requirement can be formalized with the constraints in (16a,b) which outrank the general alignment constraint (16c) defining the optimal position of INFL as adjacent to the MacroStem:

(16)(a) **AlignPart**: Align(R, Participial INFL; L, PhStem)
Align the right edge of the Participial INFL with the left edge of a PhStem.
(b) **AlignFut**: Align(R, Future INFL; L, PhWord)
Align the right edge of the Future INFL with the left edge of a PhWord.
OUTRANK
(c) **AlignINFL**: Align(R, INFL; L, MacroStem)
Align the right edge of INFL with the left edge of a MacroStem.

What remains to be explained is why the empty morphs do not surface when not needed to satisfy prosodic well-formedness. I propose this can be accounted for by ranking constraint (16c) above MAX-IO and below the prosodic constraints (Onset, Minimality >> AlignINFL>>MAX-IO). As shown in (17), this optimizes deleting the empty morphs when the morphological MacroStem is prosodically well-formed:

(17)[9]

(i) Future

	Align Fut	Align /ku/	Onset	FtMin	DEP-IO	Align INFL	MAX-IO
/si-za=ku-lwa/							
√ (a) si:za=[ku:-{lwa						*	
* (b) si:za=[{lwa				*!			**
/ba-za=ku-eqa/							
√ (c) ba:za=[kw-{e:qa						*	
* (d) ba:za=[{e:qa			*!				**
/si-za=ku-thiya/							
√ (e) si:za=[{thi:ya							**
* (f) si:za=[ku-{thi:ya						*!	

(ii) Participial

	Align Part	Align /si/	Onset	DEP-IO	PhStem Min	Align INFL	MAX-IO
/be=(si)-pha/							
√ (a) be=[si-{pha						*	
* (b) be=[{pha					*!		**
/be=(si)-akha/							
√ (c) be=[s{akha						*	*
* (d) be=[{akha			*!				**
/be=(si)-bona/							
√ (e) be=[{bona							**
* (f) be=[si-{bona						*!	

As shown in the tableaux in (17), the empty morphs, /ku/ and /si/ optimally surface when the MacroStem is monosyllabic or V-initial. Even though maintaining the morphs in the output violates AlignINFL (16c), deleting them leads to violations of the higher ranked prosodic well-formedness conditions (Onset, Minimality) on PhStem and PhWord. However, as shown in (17ie, iie), when the morphological MacroStem satisfies Onset and Minimality, it is optimal to delete the empty morphs to satisfy AlignINFL (16c).

To sum up this section, I have shown that two INFL stems of Ndebele, the Future and the Participial, take a morpho-prosodic constituent as their base for affixation, as well as their morphological base, the MacroStem. This best explains why the base of both INFLs is

[9] In the tableaux in this section, '=' indicates the INFL=MacroStem juncture, '[' indicates PhWord (future) or PhStem (participial) edge, '{' indicates the MacroStem edge. Even though the empty morphs are shown as ordered in the input for typographic reasons, it is important to remember they are actually ordered only in the output by alignment constraints.

subject to minimality: (morpho-)prosodic constituents are typically required to be prosodically well-formed. I have also shown that the Future and Participial do not take the same morpho-prosodic constituent as their base. Rather, the Future takes the PhWord while the Participial takes the PhStem. Finally, I have shown that the empty morphs which occur to satisfy minimality fail to occur otherwise because these morphs have only a morpho-prosodic affiliation, not a morpho-syntactic one. As a result, they interfere with the proper morpho-syntactic alignment of the INFL and MacroStem within the verb word when they do surface. This misalignment is optimal when it improves prosodic well-formedness. When it does not, the empty morphs are deleted.

6 Conclusion

In sum, I have argued that minimality conditions the surface form of four forms of Ndebele verbs: the imperative, reduplicative, future and participial. While all four are required to be bisyllabic, I have shown that property does not fall out from a single general minimality constraint, as we might expect given Generalized Template Theory (McCarthy & Prince 1994, 1995, 1999; Urbanczyk 1995, 1996; and Walker 2000; etc.). Instead, I have shown that three different constraints are necessary, because three different morpho-prosodic constituents with different properties are motivated by this data. The imperative and the base for the future are parsed into PhWord, as shown by the patterns of tone and length assignment to these forms (and the morpho-syntactic independence of the imperative). These same phonological patterns show that neither RED nor the base of the participial are PhWords even though they, too, are minimally bisyllabic. The base of the participial was shown to be PhStem, a subconstituent of PhWord mostly coextensive with the morphological Macrostem. The RED was argued to be a distinct morpho-prosodic entity since, unlike the others, it is subject to a maximality as well as a minimality constraint. While this property makes RED resemble a metrical foot, the RED is not plausibly parsed into a metrical foot since it is not stressed. Only the bisyllabic minimality of PhWord arguably follows from a general requirement that PhWords contain at least one stress foot. PhStems are subject to a distinct minimality requirement from PhWords, because, like RED, they are not always parsed into a stress foot. Further, unlike the other morpho-prosodic constituents, PhStems do not always satisfy minimality on the surface since epenthesis cannot be appealed to to satisfy minimality. This paper, then, contributes to our understanding of the variety of sublexical morpho-prosodic constituents cross-linguistically, and to our understanding of the variety of ways prosodic constraints on these constituents can be satisfied.

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The distribution of trimoraic syllables in German and English as evidence for the phonological word*

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1 Introduction

The following English and German words contain what I refer to below as 'trimoraic syllables', i.e. the underlined portion consists of either (i) a long vowel + one consonant, (ii) a diphthong + a single consonant or (iii) a short vowel + two consonants. In approaches to phonology in which vowel and consonant length is expressed in terms of moras all of the underlined strings in (1) can thought of as consisting of three such units. In (1) and below all German examples are presented in the left hand column and the English ones in the right.

(1a) *Trimoraic syllables in word-final position:*
Werk 'work' arm

(1b) *Trimoraic syllables before a compound boundary:*
Werk-statt 'workshop' arm-chair

(1c) *Trimoraic syllables before a consonant-initial suffix:*
fünf-zig 'fifty' event-ful

Three contexts in which trimoraic syllables occur can be gleaned from (1), i.e. before a word boundary in (1a), before a compound boundary in (1b) and before a consonant-initial suffix in (1c), i.e. a suffix of the form –CV(C).[1]

An important generalization governing trimoraic syllables in German and English is that they are, in general, restricted to surfacing in the three environments in (1). By contrast, underlined sequences like the ones in (1) are typically non-occurring morpheme-internally; thus, the moraic portion in the vast majority of morpheme-internal syllables is bipositional, e.g. German *Garten*, English *garden*. An important point made below is that under certain completely predictable conditions, trimoraic syllables in both languages can indeed surface within a morpheme, e.g. German *Mond-e* 'moons', English *chamber*.

* An earlier version of this article has benefitted from comments by the following individuals (listed alphabetically): Silke Hamann, Renate Raffelsiefen, Marzena Rochoń and Sabine Zerbian. All errors are my own.

[1] In this article I restrict my analysis to Modern Standard German (Krech et al. 1982, Drosdowski et al. 1990, 1995) and to General American English (Kenyon & Knot 1953), although I make some passing comments in the text to other varieties of these two languages.
The German and English examples like the ones in (1) bear a strong resemblance to the equivalent facts from Dutch (see Kager & Zonneveld 1986 and Kager 1989). A question I consider worthy of further research is to investigate the extent to which the generalizations established in the present article hold for all (West) Germanic languages.

In the present article I discuss the distribution of trimoraic syllables in German and English. The reason I have chosen to analyze these two languages together is that the data in both languages are strikingly similar. However, although the basic generalization in (1) holds for both German and English, we will see below that trimoraic syllables do not have an identical distribution in both languages.

In the present study I make the following theoretical claims. First, I argue that the three environments in (1) have a property in common: they all describe the right edge of a phonological word (or prosodic word; henceforth pword). From a formal point of view, I argue that a constraint I dub the THIRD MORA RESTRICTION (henceforth TMR), which ensures that trimoraic syllables surface at the end of a pword, is active in German and English. According to my proposal trimoraic syllables cannot occur morpheme-internally because monomorphemic grammatical words like *garden* are parsed as single pwords. Second, I argue that the TMR refers crucially to moraic structure. In particular, underlined strings like the ones in (1) will be shown to be trimoraic; neither skeletal positions nor the subsyllabic constituent rhyme are necessary. Third, the TMR will be shown to be violated in certain (predictable) pword-internal cases, as in *Monde* and *chamber*; I account for such facts in an Optimality-Theoretic analysis (henceforth OT; Prince & Smolensky 1993) by ranking various markedness constraints among themselves or by ranking them ahead of the TMR. Fourth, I hold that the TMR describes a concrete level of grammar, which I refer to below as the 'surface' representation. In this respect, my treatment differs significantly from the one proposed for English by Borowsky (1986, 1989), in which the English facts are captured in a Lexical Phonology model by ordering the relevant constraint at level 1 in the lexicon.

This article is structured as follows. §2 consists of a short summary of the arguments presented in the literature on pwords in German and English. In §3 I present examples from German and English illustrating the maximal size of the syllable. A formal treatment of these data is proposed in which the facts from both languages are analyzed as trimoraic. §4 discusses the distribution of underlined strings as in (1) within grammatical words. Here I argue that the three contexts in (1) should be reduced to one, namely the right edge of a pword. The consequences my analysis has for the prosodic structure of affixed words are discussed in §5. §6 presents systematic exceptions to my analysis, i.e. trimoraic syllables that are internal to a pword, e.g. German *Monde*, English *chamber*. Here I argue that such data can be accounted for by ranking constraints referring either to syllable well-formedness or to paradigm uniformity. §7 concludes.

2 Evidence for the pword in German and English

This section contains a brief discussion of the arguments for pwords in German and English and of the relationship between morphological structure and pwords in both languages. The material presented here will play a pivotal role in the analysis presented in the remainder of this article.

The pword is that constituent of the prosodic hierarchy larger than the foot but smaller than the phrase and is the smallest prosodic unit that must align with the edges of morphemes (see below). For studies of the pword in languages other than German and English see Dixon (1977a, b), Selkirk (1978), Booij (1983), van der Hulst (1984), Nespor & Vogel (1986), McCarthy & Prince (1986), Cohn (1989), Kang (1991), Prince & Smolensky (1993), Hannahs (1995a, b) and Peperkamp (1997). A more in depth survey of the literature, and of the (cross-linguistic) arguments for pwords see Hall (1999a). A central claim made by all of the authors cited above is that the pword is not coterminous with the grammatical word; thus, it is uncontroversial that a single grammatical word can consist of two or more pwords (e.g. a compound word). Most, but not all, of the linguists cited above also believe that a single pword can consist of two or more grammatical words (e.g. a host + enclitic).

2.1 German

A number of linguists have argued that the pword plays a central role in German phonology and prosodic morphology, e.g. Booij (1985), Yu (1992a), Iverson & Salmons (1992), Wiese (1996), Hall (1998, 1999b) and Raffelsiefen (2000). Although none of these authors agrees completely on how morphologically complex grammatical words should be parsed into pwords, there is a general consensus that the morphological configurations in the first column in (2) have the pword structure as indicated in the sample words in the second column. In (2) and below the pword is abbreviated as 'ω'.

(2)	(i) stem	$(\text{lieb})_\omega$	'love (imp. sg.)'
	(ii) stem+suffix containing no vowel	$(\text{lieb-t})_\omega$	'love (3p. sg. ind. pres.)'
	(iii) stem+vowel-initial suffix	$(\text{lieb-e})_\omega$	'love (1p. sg. ind. pres.)'
	(iv) stem+consonant-initial suffix	$(\text{lieb})_\omega$ -lich	'dearly'
	(v) prefix+stem	ver-$(\text{lieb-t})_\omega$	'in love'

(2) can be thought of for purposes of this ariticle as an algorithm which maps the morphological configurations in the first column into corresponding pword structure. From a formal point of view, the algorithm in (2) can be expressed in at least two different ways, e.g. a rule-based mapping (see Nespor & Vogel 1986, Cohn 1989, Hannahs 1995a, b), or as an OT-based approach in which (alignment) constraints are utilized (see Selkirk 1995, Peperkamp 1997, McCarthy 2000). I assume the latter option here but do not formalize the constraints because they would detract from the issues discussed in the remainder of this article. At any rate the constraints that guarantee the parsings in (2) are undominated in

German (and English, see §2.2), i.e. their effects cannot be undone by higher ranked constraints.

Let us now consider (2i)-(2v) in more detail. The parsings in (2i) and (2ii) are uncontroversial in the literature. The category 'stem' in (2i) subsumes monomorphemic words belonging to a major lexical category, i.e. noun, verb, adjective, adverb, preposition. By contrast, function words typically do not form their own pwords (see Hall 1999b for discussion). The status of bound stems that do not belong to lexical categories will be discussed in §6.5. The category 'stem' is also intended to subsume each part of compound words, e.g. the word *Bahnhof* 'train station' is parsed $(\text{Bahn})_\omega(\text{hof})_\omega$. The pword structure indicated in (2ii) follows directly from the prosodic hierarchy: If the pword dominates the syllable, and if the suffix here is syllable-final, then it must also be final in the pword.

Several remarks concerning (2iii), (2iv) and (2v) are in order here. The crucial difference between (2iii) and (2iv) is that the suffix in the former configuration belongs to the same pword of the stem, whereas the suffix in the latter context does not. Following earlier writers, I refer to suffixes like *–e* in (2iii) as 'cohering' and to ones like *–lich* in (2iv) as 'noncohering'. In (2iii) and (2iv) we see that the phonological shape of the suffix determines its status as cohering or noncohering: Vowel-initial suffixes are cohering and consonant-initial ones are noncohering.[2] By contrast, all prefixes (see (2v)) are noncohering, regardless of their segmental composition or stress contour.

Although there is consensus that suffixes of the form –CV(C) like *–lich* in (2iv) are noncohering, there is some controversy involving whether or not they form their own pwords. With respect to (2v), there is agreement in the literature that stressed prefixes like *un-*, *mit-*, *an-* etc. are independent pwords, but there is no consensus concerning the status of unstressed prefixes, e.g. *ver-*, *zer-*, *er-*, and *ent-*. I return to these controversial issues in §5.

A final remark needs to be made concerning the algorithm in (2). Since (2) maps either a single morpheme or a sequence of morphemes into pwords it is not possible for an arbitrary sequence of sounds within a morpheme to be an independent pword. This generalization is often implicit in rule-based work done on prosodic phonology (e.g. Nespor & Vogel 1986) because the algorithms typically only refer to entire morphemes, as in (2). The same generalization is captured in OT-based frameworks with constraints aligning pwords with morphemes. I return to the question of whether or not an arbitrary sequence of sounds within a morpheme should enjoy the status of an independent pword in §6.5.[3]

Three arguments that the pword is a constituent of German are presented in (3). (3i) and (3ii) are from Hall (1999b) and (3iii) is assumed in some form or another by certain writers (see below). The constraint MINIMALITY in (3i), familiar from other languages, also holds for

[2] It should be noted that *–artig* is an apparent exception, e.g. *sand-artig* 'sand-like'. All authors agree that *-artig* lies outside of the pword of the stem. See my comments on *–artig* in §4 below.
[3] However, several studies implicitly challenge the claim that the pword cannot consist of an arbitrary sequence of sounds. See, for example, Wennerstrom (1993), Inkelas (1993), and Peperkamp (1997).

German. The two phonotactic constraints in (3ii) bar various segments at the edge of or within a pword.

(3) (i) MINIMALITY: The pword is minimally bimoraic
(ii) LAX VOWEL CONSTRAINT: * [ɪ ʏ ɛ œ ʊ ɔ])$_\omega$
LAX VOWEL HIATUS CONSTRAINT: * ([ɪ ʏ ɛ œ ʊ ɔ] [–cons])$_\omega$
(iii) LAW OF INITIALS (LOI): In (...C.C...)$_\omega$, CC does not occur word-initially.

Significantly, criteria (3i) and (3ii) together provide evidence that both stems (i.e. (2i)) and prefixes should be parsed as separate pwords, since no stem or prefix ends in [ɪ ʏ ɛ œ ʊ ɔ], nor does any stem or prefix have fewer than two moras.[4] (3i) and (3ii) together also imply the parsings in (2iii) and (2iv), since the pwords in these structures are never subminimal, nor do they end in [ɪ ʏ ɛ œ ʊ ɔ].

A number of authors have argued that the domain of syllabification (in German, English and in other languages) is the pword, although the exact form of this rule/constraint varies from author to author (see Booij 1985, Yu 1992a, Wiese 1996, Hall 1998, Raffelsiefen 2000 for German). All of these authors have observed that a stem-final consonant syllabifies into the onset of a vowel-initial suffix but not into the onset of a consonant-initial suffix, even if the adjacent consonants otherwise occur syllable-initially, e.g. *lieb-e* [liː.bə] in (2ii) vs. *lieb-lich* [liːp.lɪç] in (2iii), cf. *nebl-ig* [neː.blɪç] 'foggy'. For purposes of this article I assume that the 'syllabification condition' refers to the LAW OF INITIALS in (3iii) (Vennemann 1972, Raffelsiefen 1999b for similar but not identical formulations). LOI is undominated in English and highly ranked in German (see §6.1 for discussion).

2.2 English

In contrast to German, there is little consensus concerning the pword structure in English (see Aronoff & Sridhar 1983, Booij & Rubach 1984, Raffelsiefen 1993, Wennerstrom 1993, McCarthy 1993, and Raffelsiefen 1999a, 1999b for various approaches).

Following Raffelsiefen's (1999b) treatment of English word formation, we can postulate that the algorithm in (2) for German is essentially the same for English. Thus, monomorphemic words (=(2i)) and sequences of stem+suffix containing no vowel (=(2ii)) parse into separate pwords, e.g. (love)$_\omega$, (love-s)$_\omega$. Several arguments (one of which will be presented below) suggest that vowel-initial suffixes of English have the cohering representation in (2iii), and that consonant-initial ones have the noncohering one in (2iv), e.g.

[4] This generalization holds only for prefixes which contain full (i.e. unreduced) vowels because German also has the two prefixes *ge-* [gə] and *be-* [bə] (see §5 below). Since no pword contains a schwa as the only vowel these prefixes are not separate pwords. One exception to the generalization that stressed prefixes are always bimoraic is *a-* [a], e.g. *agrammatisch* 'agrammatical' (see Hall 1999b and Raffelsiefen 2000).

(pimpl-ous)$_\omega$, (rump)$_\omega$less. Arguments that English prefixes are noncohering, as in (2v), are presented in Raffelsiefen (1999a).

One argument that for the distinction between the cohering structure in (2iii) and the noncohering one in (2iv) is syllabification, i.e. the LOI in (3iii). As a representative example, consider the following words in (4) (from Raffelsiefen 1999b). The first word contains a stem + vowel-initial suffix and the second one a stem + consonant-initial suffix.

(4)	pimpl-ous	[pʰɪm.pʰləs]
	rump-less	[ɹʌmpˀ.ləs]

According to Kahn (1976) the /p/ is aspirated in a word like *pimpl-ous* and (optionally) unreleased and glottalized in an example like *rump-less*; this suggests alternate syllabifications, i.e. the /p/ in the former word is syllable-initial and in the latter word syllable-final. The LOI, which as mentioned above is undominated in English, would be violated in the second form in (4) if this were a single pword, since many English words begin with /pl/. That the parsing [ɹʌmpˀ.ləs] violates the LOI can be explained if this word has the noncohering representation mentioned above.

3 Syllable and moraic structure

In §3.1 I discuss the syllable structure of German and English words like the ones in (1) and present a new proposal in which I account for the maximal syllable in both languages in terms of moraic structure. In §3.2 I compare my approach with other previous ones.

3.1 A new proposal

The following German and English words have been divided into three categories based on the structure of the 'rhyme' part of the syllable. In (5a) it consists of a short vowel plus two consonants, in (5b) a long vowel plus a single consonant and in (5c) a diphthong plus a single consonant. All relevant strings in (5) and below have been underlined.

(5a)	short vowel+two consonants		
	k<u>alt</u>	'cold'	w<u>ilt</u>
	K<u>alb</u>	'calf'	p<u>ark</u>
	kr<u>ank</u>	'sick'	s<u>ink</u>
	pl<u>ump</u>	'awkward'	l<u>amp</u>
(5b)	long vowel+one consonant		
	v<u>iel</u>	'much'	d<u>oom</u>
	L<u>ob</u>	'praise'	r<u>oot</u>
	R<u>ahm</u>	'cream'	s<u>eem</u>

(5c)	diphthong+one consonant		
	Zeit	'time'	hike
	Baum	'tree'	house
	euch	'you (2p. pl. acc.)'	noise

Some cooccurrence restrictions govern the vocalic element(s) and the final consonant(s) in words like the ones in (5), but in general the final consonant is not restricted with respect to place of articulation, i.e. it can be labial, dorsal, or coronal.

A number of writers (see below) have observed that syllables like the ones in (5) can only be followed by coronal obstruents. Some representative examples have been presented in (6). The words in (6a) include a single coronal obstruent to the right of underlined strings like the ones in (5) and the ones in (6b) include two coronal obstruents. All relevant coronals have been underlined.

(6a)	Mond	'moon'	fiend
	Freund	'friend'	find
	Feind	'enemy'	sound
	Haupt	'chief'	count
	Markt	'market'	pounce
	Fuchs	'fox'	launch
	Krebs	'cancer'	lounge
	film-t	'film (3p. sg.)'	film-ed
	feil-sch	'bargain (imp. sg.)'	pond-s
	Wurf-s	'litter (gen. sg.)'	six-th
(6b)	Herbst	'autumn'	find-s
	hilf-st	'month (2p. sg. ind.)'	pounce-d
	feilsch-st	'bargain (2p. sg.)'	

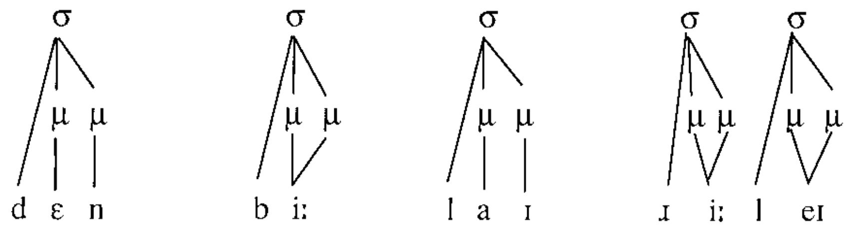
Note that the final coronal obstruent(s) can either be tautomorphemic with the preceding segments, as in the first seven German and English pairs in (6a), or they can belong to a separate morpheme. Both German and English seem to prefer no more than two coronal obstruents after underlined strings like the ones in (6).[5]

My analysis of the data in (5) and (6) relies on the assumption that the only elements intervening between the segments and the syllable node is the mora; hence, there are neither

[5] The pronunciation of the genitive singular of *Herbst* 'autumn' and *Obst* 'fruit' as *Herbsts* and *Obstes* suggests that German allows up to three coronal obstruents after a VCC or V:CC sequence. However, some linguists have noted that the preferred pronunciation for these words is with [əs], i.e. *Herbstes* and *Obstes* (see Vennemann 1982: 299, Wiese 1988: 101, footnote 21). The only other German example to my knowledge with three coronal obstruents following a VCC or V:CC sequence is the final word in (6b).

skeletal positions nor traditional subsyllabic constituents, e.g. onset, rhyme (see Hyman 1985, McCarthy & Prince 1986, Hayes 1989, Zec 1995 for similar proposals regarding syllable and mora geometry). Onset consonants link directly to the syllable node and nuclear and coda consonants to the mora (cf. Hayes 1989), as illustrated in the sample representations for the four words *den, bee, lie* and *relay* in (7):

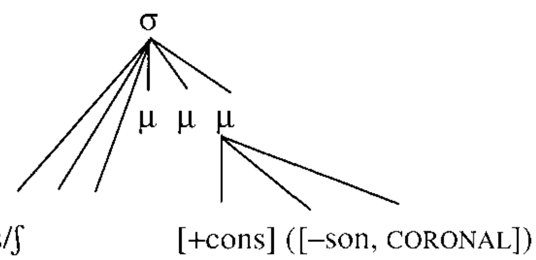
(7)



The moraic portion of the syllables in (7) consists of either (i) a short vowel + one consonant, (ii) a long vowel, or (iii) a diphthong. All of the syllables in (i)-(iii) are identical in the sense that they are bimoraic.

An important ingredient in my analysis is that the maximal syllable of German and English contains exactly three moras (see Féry 1995, 1997 for a similar proposal for German). From a formal point of view, I propose that both German and English have the following template for the maximal syllable:

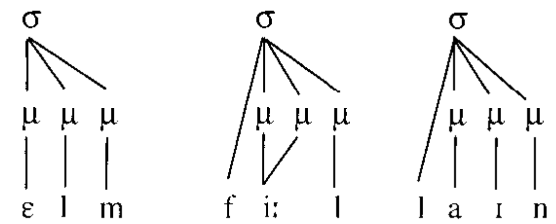
(8) The maximal syllable of German and English:



The structure in (9) says that the syllable dominates maximally three moras, where the third one is always linked to a single consonant and optionally to two coronal obstruents.[6] The syllable can begin with a maximum of three segments, the first of which is [s] or [ʃ].

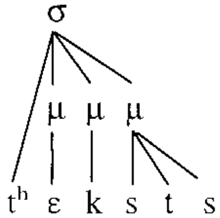
Sample structures for the three words *elm, feel* and *line,* which are representative of the examples in (6), have been presented in (9). In these words the final consonant is linked directly to the third mora:

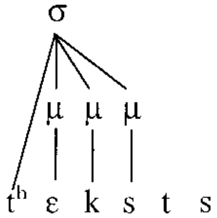
[6] In some varieties of American English (including my own) consonants other than coronal obstruents can surface after [oːɹ], e.g. *fork, absorb, form,* etc. (see Hammond 1999). I have no explanation for why [oːɹ] is the only sequence of long vowel plus consonant, after which a noncoronal obstruent can appear. For purposes of this article I assume that [oːɹ] is (exceptionally) bimoraic, i.e. [oː] is linked to two moras and [ɹ] to the second of these moras. Given the bimoraic sequence [oːɹ], noncoronal obstruents can follow because they do not violate the template in (8). In §6.3 I argue that other sequences of VCC in English are exceptionally bimoraic.

(9) 

It should be noted that some versions of moraic theory impose an upper limit of two moras per syllable and only invoke trimoraic syllables under marked circumstances (see, for example, Hayes 1989). Three languages in which trimoraic syllables have been argued to exist include Komi, Hindi and Estonian (see Hayes 1989, Kenstowicz 1994: 430-431), and in the Germanic family Proto-Germanic (Hayes 1989), Dutch (Kager 1989), the Dithmarschen/Staudenhagen dialect of German (Hock 1986, Hayes 1989), and Standard German (Féry 1995, 1997).[7]

Consider now the representation for *texts* in (10a), which is representative of the words in (6). This example illustrates that the final mora can dominate up to three consonants, the final two of which are coronal obstruents (= the maximal expansion under the third mora in (8)).

(10a) 

(10b) 

An important aspect of my analysis is that final coronal obstruents like the ones in (6) are linked directly to the third mora. This treatment is clearly at odds with the often assumed alternative view that final coronal obstruents are 'stray' in the sense that they are situated outside of the syllable, as in (10b). For analyses in which such stray coronals are presupposed see Wiese (1988: 99-102, 1991: 114ff.), Yu (1992b: 174), Wiese (1996: 47-49; 55-56) and Grijzenhout (1998: 31-32) for German; Kiparsky (1981: 253-255), Borowsky (1986: 180ff.), Giegerich (1992b: 144ff.), and Kenstowicz (1994: 259-261) for English. Representations like the one in (10a) are the crucial difference between the present proposal and the one made for Standard German by Féry (1995, 1997), who assumes that final coronals are stray, as in (10b).[8]

[7] Féry (1995, 1998) argues that her equivalent of the moraic representations in (9) derives support from German word stress, which refers to quantity. For an earlier (nonmoraic) treatment in which German word stress is held to be quantity-sensitive see Giegerich (1985). By contrast, Wiese (1996) argues that the German word stress rule is not quantity-sensitive.

[8] In several current studies it has been proposed that stray consonants like the ones in (10b) are linked to a higher constituent in the prosodic hierarchy, e.g. the pword or the foot. See, for example, Rubach (1997) and Rochoń (2000: 130-135) for Polish and Green (2000) for Attic Greek and Munster Irish.

The analysis contained in the present article is based on the presupposition that the maximal syllable template in (8) — as well as the generalization I posit in (12) below which accounts for their distribution — are *surface* representations and not *abstract* representations that exist at an early stage in the derivation. The reason the analyses cited in the preceding paragraph with stray coronal obstruents require abstract syllables is that they typically presuppose a rule of 'stray segment adjunction' that associates the stray segment(s) in (10b) with the syllable at a later stage in the derivation.[9] Linguists who posit a rule of stray segment adjunction include Wiese (1991: 123-124), Yu (1992a: 29, 1992b: 175), Wiese (1996: 56) for German and Kiparsky (1981: 254), Borowsky (1986: 179-180), Kenstowicz (1994: 258-261) for English. The reader is referred to Fudge (1969: 265ff.), Spencer (1996: 98-100), Roca & Johnson (1999: 286ff.) and Hall (2000) for analyses of English in which final coronal obstruents as in (7) are analyzed as belonging to the syllable and not as 'stray', as in (10b).

I assume that short and long vowels are associated with the respective moraic structures in the underlying representation but that postvocalic moras are derived by the constraints (i)-(iii) in (11a). The constraint WEIGHT BY POSITION (WBP) (see Hayes 1989) guarantees that a syllable-final consonant following a short vowel is dominated by its own mora and 3-μ that a syllable-final consonant or consonants following two moras is dominated by a third mora. Independent phonotactic constraints predict that the second and third consonants under the third mora are coronal consonants. DEP-μ is the constraint that prohibits the insertion of a mora. The language specific ranking for German and English is presented in (11b).

(11a) (i) WBP: A syllable-final consonant following a short vowel is moraic
(ii) 3-μ: A syllable-final consonant or sequence of consonants following two tautosyllabic moras is moraic
(iii) DEP-μ: No insertion of a mora.

(11b) WBP, 3-μ » DEP-μ

The ranking WBP » DEP-μ ensures that words like the ones in (7) are parsed as indicated. The ranking 3-μ » DEP-μ guarantees the parsings in (9) and (10a). I show below in §6 that for English (but not for German) 3-μ is dominated by two other constraints.

The advantage of analyzing the maximal syllable of German and English as trimoraic is that this representation allows one to make a simple and straightforward statement concerning the distribution of underlined strings like the ones in (5) within grammatical words. In contrast to bimoraic syllables like the ones in (7), syllables dominating three moras, as in (9), have a restricted occurrence in the sense that (generally speaking) they cannot surface morpheme-

[9] In placing an emphasis on the surface representation I have been influenced not only by recent work done in Optimality Theory (Prince & Smolensky 1993), but also by earlier work done on Natural Phonology (Stampe 1973), Natural Generative Phonology (Hooper 1976) and approaches to language change (e.g. Vennemann 1988).

internally, e.g. monomorphemes like **areelba* and **agelmda* do not occur. In §4 I discuss the distribution of trimoraic syllables in detail and conclude that their occurrence should be accounted for by referring to the pword, as I noted in §1 above. The proposal I defend in that section is encapsulated in the constraint in (12):

(12) THIRD MORA RESTRICTION (TMR):
The third mora only surfaces at the end of a pword.

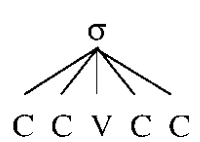
I assume for purposes of this article that the TMR is a 'primitive' constraint, although it would be possible to replace it with an alignment constraint stating that the right edge of a trimoraic sequence aligns with the right edge of a pword. Nothing in my analysis crucially requires the second option.[10]

3.2 Alternative proposals

An obvious alternative to the template in (8) and to representations like the ones in (9) and (10a) is one in which reference is made not to moras, but instead to skeletal positions and/or traditional subsyllabic constituents, i.e. the rhyme. In this section I discuss various options along these lines that have been proposed in the literature for English and German, as well as one alternative that has to my knowledge not been explicitly stated in print, and show that they are all inferior to the moraic approach I outlined in the previous subsection.

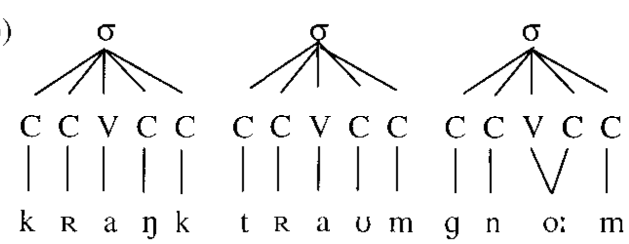
Based on an earlier study by Moulton (1956), Wiese (1988) argues that the German facts presented in §3.1 can be explained by referring to the number and type of skeletal positions within a syllable. Specifically, he argues that the German syllable has the maximum form in (13a), i.e. a single V slot preceded and followed by two C positions respectively. The template in (13a) is also accepted in Wiese's later publications (e.g. Wiese 1991, 1996).

(13a)



The 'maximal' syllable (Wiese 1996)

(13b)

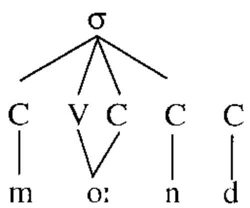


Sample representations of the three German words *krank* 'sick', *Traum* 'dream', and *Gnom* 'gnome' consisting of the maximum syllable in Wiese's model in (13a) have been presented

[10] One might assume that three segment onsets (e.g. German *Straße* English *street*) surface only in pword-initial position — a treatment that would require that VsCCV be parsed Vs.CCV in words like *astrology*. The reason I assume that VsCCV is parsed V.sCCV (and therefore that sCC can surface pword-internally) is that the stop following [s] is unaspirated.

in (13b). Note that Wiese's treatment requires long vowels to be analyzed structurally as VC and not as VV as is commonly assumed (e.g. Clements & Keyser 1983).

Mouton (1956) and Wiese (1988, 1996) observe correctly that trimoraic structures (= the VCC part of (13a)) can only be exceeded by coronal obstruents (see (6)). The latter author concludes that since there is no slot for such consonants in template (13a), that they are situated outside of the syllable.[11] A representative example for the German word *Mond* is provided in (14):

(14)


I reject analyzing the maximal rhyme of German (or English) as VCC, as in (13a), for two reasons. First, the structure in (14a) does not describe a *surface* syllable of German. The reason the structure in (14) is an abstract syllable and not a surface syllable is that the word-final coronal obstruents like the one in (14) undergo Final Devoicing (= [moːnt]). Since Final Devoicing affects syllable-final obstruents[12] the 'stray' /d/ in a word like the one in (14) must be linked up with the syllable at a later stage in the derivation (see Hall 1992: 124-126 for a rule-based approach of German in which these sequences of steps is made explicit). An advantage of the present proposal is that the template in (9) holds for the surface representation and does not require reference to an abstract stage in a derivation.

The second reason I reject an analysis in which the maximal rhyme is VCC, as in (13a), is that it does not allow the TMR in (12) to be stated in an satisfactory way. Thus, assuming the template in (13a), one could only describe the part of the syllable with a restricted distribution as 'VCC plus following coronal obstruents', but neither 'VCC', nor 'VCC plus coronal obstruents' form a constituent in (13). By contrast, the moraic model I sketched in the preceding section allows one to describe the part of the syllable that has a restricted distribution in a unified way, namely the third mora.

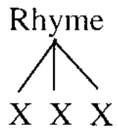
A conceivable alternative to the one in (13a) is a template in which the subsyllabic constituent 'rhyme' mediates between the skeletal tier and the syllable node. An analysis

[11] Wiese makes a similar generalization concerning the onset (= the first two C positions in (13a)): Two-member onsets can be preceded by [s ʃ], which must be located outside of the syllable because they do not fit into template (13a).

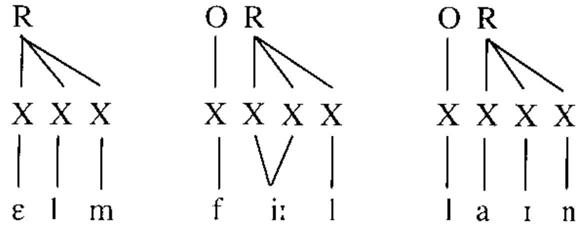
[12] Considerable discussion in the literature has been devoted to the environment of German Final Devoicing (see, for example, Vennemann 1972, Wurzel 1980, Hall 1993, Brockhaus 1995 and Wiese 1996 and references cited therein). A commonly assumed alternative to the syllable final environment is that all obstruents are devoiced within a subsyllabic constituent (e.g. coda, rhyme, mora).

along these lines might analyze the maximal rhyme of German and English as in (15a). Sample representations of the three English words *elm, feel* and *line* are presented in (15b):

(15a) The maximal rhyme of English:

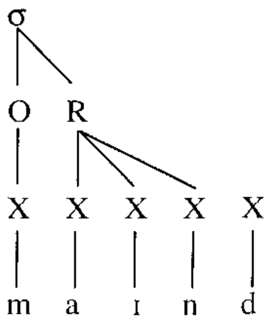


(15b)



Giegerich (1992b: 144ff.) assumes the maximal rhyme structure in (15a) for English.[13] Giegerich argues that a three member rhyme of English can only be exceeded by coronal obstruents (see (7)) and concludes that the final coronals in words like *texts* are therefore situated outside of the rhyme at the point in the derivation where (15a) holds. A typical representation for this abstract stage (see Giegerich 1992b: 148) is provided in (16):

(16)



The template in (15a) is subject to the same two criticisms that were levelled against the CV template in (13a). First, (15a) is an abstract syllable and not a surface syllable. The reason the syllable in (16) cannot be correct for the surface is that the final voiceless coronal stop in English words like *pint* undergoes the rule of Glottalization to [$t^{ʔ}$]. Since Glottalization holds syllable finally (see Kahn 1976: 84ff., Withgott 1982: 165-169, Gussenhoven 1986, Nespor & Vogel 1986: 77-78, Giegerich 1992b: 220-221, Kenstowicz 1994: 69), the implication is that this segment cannot be situated outside of the syllable on the surface.

The second criticism of (15a) is that the part of the syllable that has a restricted distribution, i.e. the 'rhyme plus coronal obstruents', is not a constituent. Assuming for the sake of argument that there is a surface based template similar to the one in (15a) in which final coronal obstruents are linked directly to the rhyme, as in (17), one could still not adequately describe the part of the syllable that has a limited distribution:

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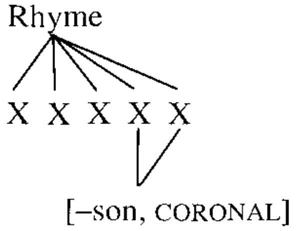
[13] See also Kiparsky (1981), Borowsky (1986: 146) and Kenstowicz (1994: 259ff.), who presuppose a template very similar to the one in (15a) which they express in alternative representational models.

(17)



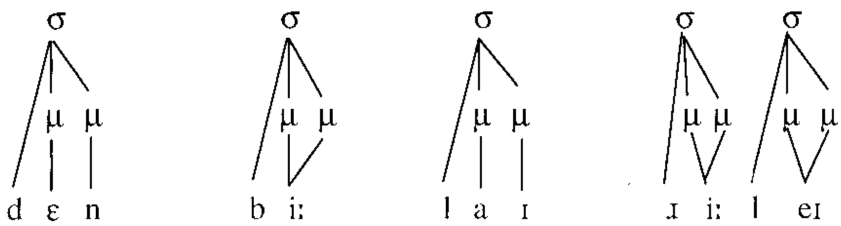
Given (17), one would be forced to say that the part of the syllable that has a restricted distribution is 'a rhyme consisting of three skeletal slots or more', but this sequence is not a constituent.

4 The distribution of trimoraic syllables

In this section I present data from English and German illustrating the distribution of trimoraic structures within grammatical words. An important goal in the following paragraphs is to demonstrate the validity of the TMR in (12).

Consider first the distribution of the bimoraic syllables in *den, bee, lie* and *relay*, cf. the representations in (7), which I repreat in (18) for convenience:

(18)



The words in (19) below all contain such bimoraic syllables. These words have been organized into one of four separate categories. All relevant bimoraic structures in these examples have been underlined. The first three environments together can be categorized as 'morpheme-final position', i.e. word-finally in (19a), before a compound boundary in (19b) and before a suffix in (19c). The fourth context is illustrated in (19d). These words show that bimoraic syllables also surface 'morpheme-internally', i.e. the bimoraic syllable and the following segment(s) are tautomorphemic.

(19a) *Bimoraic syllables word-finally*:

See	'sea'
Tau	'dew'
Bett	'bed'

(19b)	*Bimoraic syllables before a compound boundary*:	
	S<u>ee</u>-tang	's<u>ea</u>-weed'
	Sch<u>uh</u>-anzieher	'sh<u>oe</u>-horn'
	Bl<u>ick</u>-kontakt	'<u>eye</u>-contact'
(19c)	*Bimoraic syllables before a suffix*:	
	Dr<u>oh</u>-ung	'threat'
	sch<u>uh</u>-los	'sh<u>oe</u>-less'
	Fr<u>ei</u>-heit	'fr<u>ee</u>-dom'
	m<u>änn</u>-lich	'm<u>an</u>-ly'
(19d)	*Bimoraic syllables morpheme-internally*:	
	Balal<u>ai</u>ka	'balal<u>ai</u>ka'
	K<u>on</u>ferenz	'c<u>on</u>ference'
	F<u>il</u>ter	'f<u>il</u>ter'

Let us now consider the distribution of trimoraic syllables. The data in (20) below have been organized into three separate contexts: (i) before a word boundary in (20a), (ii) at the end of each part of a compound in (20b) and (iii) before a consonant-initial suffix in (20c), i.e. before a suffix of the form -CV(C). In all three contexts trimoraic syllables surface freely.

(20a)	*Trimoraic syllables in word-final position:*		
	W<u>erk</u>	'work'	<u>arm</u>
	Z<u>eit</u>	'time'	l<u>oud</u>
	B<u>aum</u>	'tree'	<u>eel</u>
	B<u>uch</u>	'book'	h<u>eight</u>
(20b)	*Trimoraic syllables before a compound boundary:*		
	W<u>erk</u>-statt	'workshop'	<u>arm</u>-chair
	Z<u>eit</u>-geist	'Zeitgeist'	l<u>oud</u>-mouth
	B<u>aum</u>-stamm	'tree trunk'	w<u>ork</u>-shop
	B<u>uch</u>-weizen	'buckwheat'	h<u>eight</u>-assimilation
(20c)	*Trimoraic syllables before a CV(C) suffix:*		
	f<u>ünf</u>-zig	'fifty'	d<u>oubt</u>-ful
	l<u>eb</u>-los	'lifeless'	f<u>ear</u>-less
	<u>Ein</u>-heit	'unit'	app<u>ease</u>-ment
	l<u>ieb</u>-lich	'dearly'	p<u>art</u>-ly

The following words all illustrate that trimoraic syllables in the three contexts in (20) can be augmented by final coronal obstruents:

(21a) *Trimoraic syllables (including coronal(s)) in word-final position*:

Mond	'moon'	sound
Herbst	'autumn'	sixth
Obst	'fruit'	text

(21b) *Trimoraic syllables (including coronal(s)) before a compound boundary*:

Haupt-mann	'captain'	sound-wave
Markt-platz	'market place'	launch-pad
Obst-garten	'fruit garden'	text-book

(21c) *Trimoraic syllables (including coronal(s)) before a CV(C) suffix*:

Freund-schaft	'friendship'	bound-less
Pünkt-chen	'little dot'	mind-ful
herbst-lich	'autumnal'	sound-ly

There is one significant difference between the bimoraic syllables in (19) and the trimoraic ones in (20) and (21), namely, trimoraic syllables are absent morpheme-internally, i.e. when tautomorphemic with the following segment(s). This gap is illustrated with three nonce forms in the first column of (22). The occurring words in the right column illustrate that bimoraic syllables can surface in a similar environment (see also (19d)):

(22) *No trimoraic syllables morheme-internally:*

*areel.ba	(cf. are.na)
*agelm.da	(cf. agen.da)
*laim.da	(cf. balalai.ka)

While the basic generalization in (22) is correct, I show below in §6 that under certain completely predictable circumstances a syllable ending in VCC or V:C can occur morpheme-internally, as in (22).

Let us now consider environment (20c) and (21c). Since the examples presented there only include consonant-initial suffixes it is important to consider the status of trimoraic syllables before vowel-initial syllables. That trimoraic syllables are typically barred from occurring in this environment is a consequence of syllabification, as illustrated in the German examples in (23). These words consist of a stem + vowel-initial suffix, where the bare stem ends in a trimoraic sequence. An examination of the phonetic forms in (23) reveals that the final syllable of the stem is bimoraic, since the stem-final consonant(s) are syllable-initial:

(23) *Bimoraic rhymes before a V(C) suffix*:

lieb-e	[liː.bə]	'love (1p. sg. ind. pres.)'
erb-en	[ɛɐ.bən]	'inherit (inf.)'

It should be noted here that the parsings in the phonetic forms in (23) are uncontroversial in the literature on German phonology because they can be motivated by language specific arguments. In this case, since the /b/ both *liebe* and *erben* do not undergo Final Devoicing we can safely conclude that they are syllable-initial and not syllable-final. In the final example /ʀ/ surfaces as [ɐ]. Since r-vocalization uncontroversially takes place in coda position (see Giegerich 1989: 47ff., Hall 1992: 56-58, 1993: 88ff., Wiese 1996: 256ff.) the implication is that a word like *erben* is parsed /Vʀ.bV/.[14]

Consider now the German examples in (24), which consist of a stem + *artig*. *–artig* is unique in that it does not alow a stem-final consonant to be in the onset, as indicated in the phonetic representations.

(24)	s<u>and</u>-artig	[zant.aɐtɪç]	'sand-like'
	zw<u>erg</u>-artig	[t͡svɛɐk.aɐtɪç]	'dwarf-like'
	b<u>aum</u>-artig	[baum.aɐtɪç]	'tree-like'
	kr<u>ebs</u>-artig	[kʀe:ps.aɐtɪç]	'crab-like'

That trimoraic syllables precede the suffix *–artig* is therefore simply a consequence of the fact that the stem-final consonant is not situated in onset position. Due to the syllabification data in (24) there is agreement in the literature that *–artig* does not belong to the same pword as the stem to which it attaches (see note 2). This can be captured formally by saying either (i) *–artig* is associated underlyingly with a pword, or (ii) *–artig* is a stem and hence gets parsed as an independent pword by (3i) (see Hall 1992: 105-106, Wiese 1996: 65, footnote 32, and Raffelsiefen 1999b: 272, who take the second option). I assume here that (ii) is correct.

The contexts in which trimoraic syllables occur are summarized in (25a) and the one environment in which they are barred from appearing in (25b) with two nonce words.

(25a)	Three contexts in which trimoraic syllables occur:		
	context	*German*	*English*
	(i) before a word boundary	W<u>erk</u>	<u>arm</u>
	(ii) before a compound boundary	W<u>erk</u>-statt	<u>arm</u>-chair
	(iii) before suffixes of the form -CV(C)	l<u>ieb</u>-lich	ev<u>ent</u>-ful
(25b)	One context in which trimoraic syllables cannot occur:		
	context	*German*	*English*
	(i) morpheme-internally	*ar<u>eel</u>.ba	*ar<u>eel</u>.ba

[14] As I note in §6.1.2 below there is no consensus in the literature on English phonology that corresponding English words (e.g. *arriv-al, help-ing*) are syllabified as in (23), i.e. [ə.ɹaɪ.vəl], [hɛl.pɪŋ]. As I point out in that section many analysts have argued that *codas* in such words are maximized, e.g. [hɛlp.ɪŋ] (see, for example, Selkirk 1982, Hammond 1999). See below for further discussion.

The analysis of pwords presented in §2 enables us to reduce the three contexts in (25a) to one: pword-final position. In all of these examples the underlined sequence is in situated at the right edge of a pword based on the algorithm with maps morphological structure into pwords in (2). Thus, (2i) predicts that *Werk* and *arm* are single pwords, that *Werkstatt* and *armchair* consist of two and that *–lich* and *–ful* do not belong to the pword of the stem *lieb* and *event*.

Consider now the gaps in (25b). The nonexistence of morpheme-internal trimoraic syllables follows directly from the algorithm presented in (2) above. Step (2i) guarantees that every (monomorphemic) stem be assigned a single pword. Monomorphemic words like **ageenda* and **agelmda* are automatically ruled out because the pword cannot 'split' a morpheme, i.e. the pword consists either of a single morpheme or more than one morpheme.

Recall from (2ii) that a string consisting of stem + vowel-initial suffix has a cohering representation, i.e. one in which the stem and suffix are mapped into a single pword. Given this parsing, one would not expect to find trimoraic structures in the corresponding stem, e.g. in a hypothetical word like *(areel.b-ing)$_{\omega}$, since they are not situated in pword-final position. In fact, the nonoccurrence of most trimoraic syllables in this context can be attributed to the nonexistence of the corresponding stems, e.g. **areelb-ing* is nonoccurring because **areelb* violates the template in (9). As I show below in §6, many German and English words do indeed exist in which a trimoraic syllable is situated in the stem in stem + vowel-initial suffix (e.g. German *Mond-e*), but they are completely systematic, i.e. there is an independent reason why the trimoraic syllable occurs in this context.

5 The pword structure of affixed words

The proposal sketched in §3 and §4 makes concrete predictions concerning the prosodic structure of affixed words. I begin this section by considering suffixation and conclude with prefixation.

The prosodic structure (i.e. moras, syllables, feet, and pwords) of affixed words in German and English is an extremely broad topic with ramifications for other aspects of the phonology and morphology of these two languages. The purpose of the present section is to apply the TMR as a diagnosic for pword structure of affixed words and to show how it does or does not correlate with other diagnostics for pwordhood proposed by other linguists.

5.1 Suffixed words

The German words in the second column of (26) consist of stems ending in a trimoraic syllable followed by the corresponding suffix in the first column. Note that all of the suffixes in (26) are consonant-initial and trimoraic. Recall from (2iv) that consonant-initial suffixes like the ones in (26) are noncohering; that is, they are not integrated into the same pword as the stem to which they attach.

(26)

suffix	*example*	
-schaft	Freundschaft	'friendship'
-heit	Feigheit	'cowardice'
-haft	krankhaft	'morbid'
-bar	lesbar	'readable'
-lein	Häuslein	'house (dim.)'
-los	leblos	'lifeless'
-sam	schweigsam	'silent'
-tum	Reichtum	'riches'

Since both the stem and suffix must be final in a pword I adopt the representation in (27) for these words. In (27) the stem and suffix are dominated by a separate foot (= F in (27) and below) to capture the generalization that the stem is primarily stressed (=F_s) and the suffix secondarily stressed (=F_w).[15] Both feet in (27) are dominated by separate pwords.

```
        ω      ω
        |      |
        Fs     Fw
        |      |
(27)   leːp   loːs
```

The representation in (27) — in particular the pword dominating the suffix — derives additional support from the fact that rule predicting the relative prominence within the constituents of a suffixed word makes direct reference to the pword (Raffelsiefen 2000).[16]

In contrast to German, there are apparently no noncohering suffixes of English that bear secondary stress which would have a representation like the one in (27) (see Raffelsiefen 1993: 102ff., 1999b: 254ff.).[17] The following German and English examples consist of a stem ending in a trimoraic syllable plus a (noncohering) consonant-initial suffix containing a reduced vowel (=schwa).

[15] There is general agreement in the literature that suffixes like the ones in (26) are secondarily stressed (see, for example, Kiparsky 1966, Reis 1974, Giegerich 1985, Eisenberg 1991, Hall 1998, Raffelsiefen 2000). By contrast, Wiese (1996) does not postulate secondary stress for the suffixes in (26). See Hall (1998) for criticisms of Wiese's approach.

[16] I leave open the nature of the prosodic constituent that dominates the two pwords in (27).

[17] As Raffelsiefen (1999b: 255) notes, vowel reduction in certain noncohering suffixes of English is blocked by various phonological conditions, e.g. *-hood, -like, -wise, -fold, -most.* She argues that these suffixes are dominated by their own feet but not by their own pwords.

(28)	*suffix*	*example*	
(28a)	-te	filmte	'film (pret.)'
	-chen	Häuschen	'house (dim.)'
	-sel	Überbleibsel	'remnant'
(28b)	-ment	statement	
	-ness	lateness	
	-ful	faithful	

Four possible representations for the words in (28) have been presented in (29), in which *filmte* is taken to be a representative example. Since the suffixes in (28) contain schwa they are clearly not dominated by their own feet or pwords (see Hall 1999b, Raffelsiefen 2000 for German and Raffelsiefen 1999b for English, who arrive at the same conclusion); hence, representation (29a) cannot be correct. (29b) is not the right representation because the final syllable of the stem violates the TMR by not being situated at the right edge of a pword. The two remaining possibilities are the recursive structure in (29c) or the one in (29d) in which the suffix is situated outside of the pword of the stem and is linked to a higher contstituent in the prosodic hierarchy that is distinct from the pword.[18]

(29a) $(\text{film})_{\omega}(\text{te})_{\omega}$
(29b) $(\text{filmte})_{\omega}$
(29c) $((\text{film})_{\omega}\ \text{te})_{\omega}$
(29d) $(\text{film})_{\omega}$ te

Since no compelling arguments come to mind in favor of (29c) over (29cd) or vice versa, I leave this question open for further study.

My conclusion concerning the pword structure of examples like the ones in (28) has consequences for previous proposals made in the literature on German concerning strings composed of stem + *chen*. I conclude this section by examining the alternatives proposed in the literature and by demonstrating that (29d) (or, alternatively (29c)) is the correct one.

A number of linguists have argued that stem + *chen* has the prosodic structure (29a) (see Noske 1990, Yu 1992a, Wiese 1996, Noske 1997). The argument these linguists give for this representation is that the rule of Dorsal Fricative Assimilation — the process whereby /ç/ assimilates in backness to a preceding central or back vowel — is restricted to applying only when the trigger and target are situated within the same pword, e.g. $(\textit{tauch-en})_{\omega}$ /tau̯-çən/ [tau̯xən] 'dive'. Since no assimilation occurs in words like *Tau-chen* 'rope (dim.)' [tau̯çən], *[tau̯xən], the phonologists cited above draw the conclusion that stem + *chen* must have

[18] For studies in which recursive pwords have been proposed see Zec & Inkelas (1991) for Serbo-Croatian, Peperkamp (1997) for the Neapolitan dialect of Italian and Wiese (1996) for German compound words.

representation (29a). As I noted above, the structure in (29a) cannot be correct because the second pword contains schwa as the nuclear element. The generalization concerning the domain of Dorsal Fricative Assimilation can still be maintained given the correct structure in (29d). Here the /ç/ does not become [x] because this segment does not belong to the same pword of the stem.[19]

Iverson & Salmons (1992) argue that German has two *–chen* suffixes, the first of which is cohering (= (29b)), and the second of which is noncohering, which the authors interpret to mean (29a). The first structure is argued to be correct for words like the ones in (30a) and the second for (30b):

(30a)	Häus-chen	'house (dim.)'
	Bäum-chen	'tree (dim.)'
(30b)	Tau-chen	'rope (dim.)'
	Pfau-chen	'peacock (dim.)'
	Tant-chen	'aunt (dim.)'

The dichotomy between cohering and noncohering *–chen* is said to be supported by the fact that (i) /ç/ in *–chen* does not assimilate to [x] in the noncohering representation in (30b) and (ii) only the stems with cohering *-chen* undergo Umlaut, whereas the latter do not. Hence, Iverson & Salmons (1992) assume that Umlaut, like Dorsal Fricative Assimilation, only operates when the suffix and the stem belong to the same pword.[20]

Significantly, the vast majority of German words containing *–chen* belong to the cohering group in (30a); hence, a consequence of Iverson & Salmons' (1992) treatment is either that the pword is not the correct domain of the TMR, or the examples in (30a) constitute idiosyncratic exceptions to it. In my treatment the correct representation for *–chen* in both (30a) and (30b) is (29d) (or (29c)), since both *–chen*'s can attach to trimoraic stems. With respect to the domain of German Umlaut it is noteworthy that Umlaut alternations occur regardless of whether or not a suffix is cohering or noncohering, e.g. *Haus* vs. *Häus-er* 'houses', *häus-lich* 'domestic'. These examples are important because they tell us that Umlaut cannot be analyzed as a rule that only applies when the trigger and target belong to the same pword.

[19] Wiese (1996: 69-72) presents a second argument for treating *–chen* as a separate pword. In particular, he argues that the element that deletes in coordinate structures is a pword; since *–chen* deletes (e.g. *Brüder- und Schwesterchen* 'brother (dim.) and sister (dim.)' from *Brüderchen und Schwesterchen*), he concludes that it is also a pword. As pointed out by Hall (1999b) and Smith (2000) the coordinate structure deletion data do not involve the deletion of a pword. Instead, the remnant, i.e. that portion of the complex word left over after deletion, is a pword.

[20] See also Féry (1995: 207ff.), who argues that productive Umlaut, as in the examples in (30a), requires a syllabic trochee consisting of the last syllable of the stem and the suffix *–chen*.

5.2 Prefixed words

The generalizations pertaining to the prosodic structure of stem + suffix sequences above also hold for strings consisting of prefix + stem. The words in the second column of (31) contain trimoraic stems that attach to the trimoraic prefixes in the first column.

(31)	*prefix*	*example*	
(31a)	aus-	Ausfahrt	'driveway'
	auf-	Aufstieg	'ascent'
	vor-	Vorstoß	'dash'
	durch-	Durchzug	'passage (through)'
(31b)	fore-	forewarn	
	post-	post-date	
	trans-	trans-act	
	out-	out-stare	

The correct prosodic structures for these words have been illustrated in (32a) for the German word *Aufstieg* and (32b) for the English word *forewarn* respectively (see Raffelsiefen 2000: 50ff.):

	ω_s	ω_w		ω_w	ω_s
	|	|		|	|
	F	F		F	F
	|	|		|	|
(32a)	aʊf	ʃtiːk	(32b)	foːɹ	wɑɹn

Note that German and English differ crucially with respect to relative prominence, as indicated with the subscripts 's' and 'w' in the structures in (32). The reason the subscripts are appended to the pword and not to the foot is that the respective stems can consist of more than one foot, e.g. German *unspektakulär* 'unspectacular' (prosodically $(\underline{\text{u}}\text{n})_\omega(\text{sp}\underline{\text{e}}\text{ktakul}\underline{\text{ä}}\text{r})_\omega$, where the underlined vowels bear some stress and are hence the heads of feet. The stress pattern in (32a) and (32b) also holds for prefix + stem, where the prefix (or stem) is bimoraic. For example, German prefixes like *an-* and *un-*, which are bimoraic, have the same stress pattern as the trimoraic ones in (31a), i.e. the prefix bears primary stress. The same generalization is true for English prefixes, e.g. *in-*, *un-*, which are stressed like the trimoraic ones in (31b).

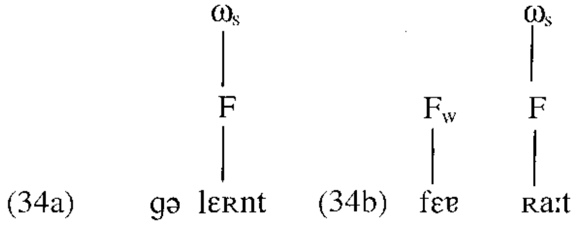
The prosodic structures in (32) — in particular the adjacent pwords — derive support from two independent sources. First, these structures are in line with the TMR, since the trimoraic syllables are final in the resepctive pwords. And second, the rules predicting the stress patterns in (32a) and (32b), refer crucially to pwords and not so some other constituent (Raffelsiefen

2000). In particular, for German a prefix that is a pword is metrically more prominent than the stem to which it attaches, but for English the reverse relation holds.

The following examples consist of unstressed German prefixes followed by trimoraic stems:

(33)	*prefix*	*example*	
	ge-	gelernt	'learned (part.)'
	be-	bewölkt	'cloudy'
	ver-	Verrat	'treason'
	zer-	zerfurcht	'furrowed'
	er-	Erfolg	'success'
	ent-	entfernt	'distant'

Consider first *be-* and *ge-*. That these two prefixes cannot be independent pwords (or feet) is attested by the fact that the vowel is schwa. Hall (1999b) and Raffelsiefen (2000) argue independently that *ge-* and *be-* cannot belong to the pword of the stem and conclude that the correct prosodic structure for words with these prefixes is the one in (34a).



Consider now *ver-*, *zer-* and *er-*. The pronunciation dictionaries do not agree on whether or not these syllables constitute reduced forms (i.e. Krech et al. 1982 transcribe the nuclear portion of these three prefixes as [ɐ] and Drosdowski et al. 1995 as [ɛɐ]). I assume that the prosodic structure varies, depending on the pronunciation: when they surface with the reduced vowel [ɐ], I assume the structure in (34a) is the correct one and when the three prefixes *ver-*, *zer-*, *er-* are realized as [ɛɐ], then they are dominated by a (weak) foot (see also Wiese 1996: 94ff.). Since the TMR does not require *ver-*, *zer-* and *er-* to be separate pwords, and since no positive evidence to my knowledge suggests this structure, I assume that representation (34b) is correct.

(34b) is also the correct structure for *ent-* (see also Wiese 1996: 94ff. and Raffelsiefen 2000: 46-47). The reason *ent-* cannot be dominated by ist own pword is that this structure would not be in line with the rule discussed after (32) above, which says that a prefix that is a pword is metrically more prominent than the stem to which it attaches. I account for the fact that the prefix *ent-* is not in line with the TMR by analyzing this morpheme as exceptionally bimoraic as opposed to trimoraic (see note 6 and §6.3 below for an analysis of exceptional moraic structure for English words).

6 Systematic and idiosyncratic exceptions to the TMR

As noted above in §4, in both German and English the TMR has a number of systematic exceptions, i.e. words containing trimoraic syllables that occur within and not at the end of a pword. Both languages also have a small number of idiosyncratic exceptions. The former are discussed in §6.1-§6.5 and the latter in §6.6.

The systematic exceptions to the TMR are significant for two reasons. First, they can be shown to follow from an OT-based model by ranking a small number of universal markedness constraints referring to syllable structure among themselves, or by ranking various markedness constraints ahead of the TMR. Second, the constraints posited below function as parameters that differentiate German and English.

6.1 Syllabification of V:CCV

Many German and English words contain a bimoraic string (= long vowel, diphthong or short vowel+consonant) followed by CCV within a pword. I abbreviate such bimoraic sequences henceforth as V:. Were the first of the two adjacent C's in such strings to be syllabified in syllable-final as opposed to syllable-initial position, i.e. V:C.CV, then such words would constitute violations to the TMR. Since many German and English words are of the form V:CCV we are therefore dealing with a large class of potential counterexamples to the TMR. In this section I argue that words containing V:CCV typically do not violate the TMR since they are syllabified V:.CCV for independent reasons. Under certain circumstances to be made explicit below, V:CCV is parsed V:C.CV. I account for such TMR violations by ranking constraints in an OT-based approach.[21]

6.1.1 German

Consider first how German words of the form VCCV are parsed in which the first C is more sonorous than the second, e.g. *Tante* 'aunt' [tantə]. There is unanimous agreement in the literature on German phonology that such words are parsed VC.CV, e.g. [tan.tə] — a syllabification that is motivated by various language internal arguments (see the discussion after (23)). The three markedness constraints in (35a), all familiar from the pre- and post-OT literature, when ranked as in (35c), predict the correct syllabification, as shown in the tableau in (35d). In (35a) and below SSG = SONORITY SEQUENCING GENERALIZATION (see, for example, Selkirk 1984, Clements 1990 and references cited therein). For purposes of this

[21] In this article I only discuss the parsing of V(:)CCV when CC represents an obstruent and a sonorant in either order. Both German and English have many words of the form V:CCV, where CC = two obstruents, e.g. English *Easter*, German *Kloster* [klo:stɐ] 'monastery'. As I pointed out in note 10, I assume that the parsing V:.sCV is correct because the C in both English and German is unaspirated in this environment.

article I am assuming the sonority hierarchy in (35b) (see Clements 1990 for a similar hierarchy and Hall 1992 and Wiese 1996 for similar proposals for German).

(35a) (i) SSG: The syllable peak is preceded and/or followed by a sequence of segments with progressively decreasing sonority values.
(ii) ONSET: Syllables are consonant-initial
(iii) NOCODA: Syllables are open

(35b) Sonority Hierarchy: vowels > glides > r > l > nasals > obstruents

(35c) SSG, ONSET » NOCODA

(35d)

	SSG	ONSET	NOCODA
→[tan.tə]			*
[ta.ntə]	*!		
[tant.ə]		*!	*

Clearly German ranks faithfulness constraints that prevent the insertion of vowels and the deletion of consonants (i.e. DEP-V and MAX-C respectively) higher than NOCODA; this is necessary to account for the fact that a surface form like [tan.tə] is better than [ta.nV.tə] or [ta.tə].[22] [23]

Note that the first vowel in the example *Tante* is short. Were a long vowel to occur before CCV then the constraint ranking in (35c) would predict a syllabification that would lead to a TMR violation, namely V:C.CV. Barring the systematic exceptions to be discussed in §6.2 and §6.4 such examples do not exist, i.e. hypothetical words like [taːn.tə] are nonoccurring. That this is a true systematic gap can be gleaned from the nativized pronunciation of loan words containing VNOV or VLOV, in which the first vowel is stressed and tense, e.g. Spanish *J[u]nta* > German *J[ʊ]nta*, Polish/Czech *P[o]lka* > German *P[ɔ]lka*. In German stressed tense vowels are always long; that the stressed vowels in such examples are realized as lax and short rather than tense and long attests to the importance of the TMR.

Consider now German examples which contain V:CCV in which CC exhibits a sonority rise. The words in (36) have been divided into three groups based on the nature of the adjacent

[22] Note that the ranking ONSET » NOCODA in (35c) also correctly predicts that V(:)CV is parsed V(:).CV. As I noted in (23) above, this parsing (as opposed to V(:)C.V) is correct because the C never undergoes processes that hold in coda position, e.g. Final Devoicing and r-Vocalization. Many German words are of the form VCV, in which the C is preceded by a short vowel, e.g. *Bitte* [bɪtə] 'request', *Roggen* [ʀɔgən] 'rye'. Most investigators have argued that the C in such examples is not in absolute syllable-initial position, but instead that it is ambisyllabic (see Ramers 1992, Wiese 1996 and references cited therein). If such parsings are correct then the present analysis requires an additional constraint that predicts that the optimal syllabification for a word like *Bitte* is [bɪtə] (with an ambisyllabic [t]) as opposed to [bɪ.tə]. The nature of this constraint is not important for purposes of this article.

[23] Recall from (6) that I analyze final coronal obstruents not as stray, as in (10b), but instead as moraic, as in (10a). Since obstruents occupy a single position in the sonority hierarchy in (35b) the analysis presented up to this point incorrectly predicts that the [t] in a word like *Markt* cannot be parsed. This point is discussed in detail in Hall (2000).

C's. In (36a) the two C's can also occur word-initially, e.g. [gn bl dʀ] in *Gnade* 'mercy', *Blitz* 'lightning', *drei* 'three'. By contrast, in (36b) and (36c) the two C's cannot occur word-initially, i.e. no German word begins with [dl dn çn çm]. The difference between (36b) and (36c) is that in the former words the first C in V:CCV is a voiced obstruent and in the latter words it is voiceless. In (36b) and (36c) I only give five examples of CC sequences that occur word-medially but not word-initially; however, additional examples for both groups can be found in the literature (e.g. Hall 1992, Giegerich 1992a, Yu 1992b).

(36a)	regn-en	[ʀe:gnən]	'rain (verb)'
	nebl-ig	[ne:blɪç]	'foggy'
	zylindr-isch	[t͡sylɪndʀɪʃ]	'cylindrical'
(36b)	Adler	[a:dlɐ]	'eagle'
	Handl-ung	[handlʊŋ]	'plot (noun)'
	ordn-en	[ɔɐdnʊŋ]	'order (verb)'
(36c)	zeichn-en	[t͡saɪçnən]	'draw'
	Atm-ung	[a:tmʊŋ]	'breath'

I hold that all of the words in (36) are parsed V:.CCV. This syllabification is uncontroversial in the examples in (36a), since these onsets occur in word-initial position; what is more, this parsing derives support from the fact that voiced obstruents do not undergo Final Devoicing. The same reasoning implies that the syllabification V:.CCV is also correct for the examples in (36b) (see Hall 1992, Giegerich 1992b, Yu 1992b), since the post-V: obstruent does not undergo Final Devoicing.[24] More controversial is the parsing V:.CCV in the words in (36c), e.g. [t͡saɪ.çnən] for *zeichnen*. Since these onsets are nonoccurring word-initially, one might be tempted to assume that these words are parsed V:C.CV, e.g. [t͡saɪç.nən], but we already know on the basis of words like the ones in (36b) that the LOI (recall (3iii)) is not exceptionless in German. In contrast to the examples in (36a) and (36b) no language internal argument exists supporting either the parsing [t͡saɪç.nən] or [t͡saɪ.çnən]. Note, however, that the adjacent C's in (36c), like those in (36a) and (36b), constitute a sonority rise when syllable-initial (recall the sonority hierarchy in (35b)). Hence, syllabifications like [t͡saɪ.çnən] not only enable us to

[24] See, however, Rubach (1992), who argues for the parsing V:C.CV in words like *Handlung*. Problematic for Rubach's approach are monomorphemic words like *Adler*.

Two examples of words like the ones in (36b) in which the parsing VC.CV appears to be correct are *Widmung* [vɪtmʊŋ] 'dedication' and *Kadmium* [katmiʊm] 'cadmium'. That the /t/ in these words was historically a /d/ suggests that this segment was (at that point in time) syllable-final and not syllable-initial. The reason these are only apparent examples for the parsing VC.CV in Modern Standard German is that the vowel preceding the /t/ is short and not long. As I mentioned in note 22 most researchers agree that the C in VCV is ambisyllabic if the first V is short. If this generalization is correct for the obstruent in VONV as well, then the /t/ in words like *Widmung* and *Kadmium* is ambisyllabic in Modern Standard German. That the historical /d/ in these examples was devoiced suggests that at one point in time this segment was in absolute syllable-final position. It is beyond the scope of the present study to determine under which conditions obstruents in VONV were syllabified into absolute syllable-final position and then later reanalyzed as ambisyllabic.

eliminate a large number of potential counterexamples to the TMR, they also make sense from the point of view of universal preference laws, i.e. they display a sonority rise consisting of an obstruent and a sonorant consonant in syllable-initial position.

I argue that the syllabification of the words in (36) falls out in an OT-based approach from the two constraints in (37a), the constraints SSG and NoCODA from (35ai) and (35aiii) respectively, and the language-specific ranking for German in (37b). The LOI in (37aii) has been repeated from (3iii).

(37a) (i) *COMPLEX: Onsets consisting of more than one member are illicit

(ii) LOI: In $(VC.CV)_{\omega}$, CC does not occur word-initially.

(37b) SSG » NoCODA » , LOI, *COMPLEX

Given the ranking for German in (37b), V:CCV is consistently parsed V:.CCV, when the second C is more sonorous than the first. This point is made clear in the following two tableaus. In (38a) we see three candidates for the word *regnen* [ʀeː.gnən] 'rain (verb)', which is representative of the words in (36a). The second candidate loses out to the first because it violates the higher ranked NoCODA twice; by contrast, the winner violates the same constraint only once. In (38b) two candidates are evaluated for the German word *Adler*, which is representative of (36b) and (36c). The LOI is not crucial in the evaluation of such words. By contrast, this constraint plays an important role in English (see §6.1.2).

(38a)

	SSG	NoCODA	*COMPLEX
→[ʀeː.gnən]		*	*
[ʀeːg.nən]		*!*	
[ʀeːgn.ən]	*!	**	

(38b)

	SSG	NoCODA	LOI	*COMPLEX
→[aː.dlɐ]			*	*
[aːd.lɐ]		*!		

Several linguists have noted that the voiced obstruents in examples like the ones in (36a) and (36b) can undergo Final Devoicing (see Vennemann 1972, Wiese 1988, Hall 1992, Giegerich 1992a). This pronunciation is usually described as being typical for a different dialect than Standard German, or a different speech register, i.e. fast/casual speech. Four representative examples have been presented in (39):

(39)	regn-en	[ʀeːknən]	'rain (verb)'
	nebl-ig	[neːplɪç]	'foggy'
	Handl-ung	[hantlʊŋ]	'plot (noun)'
	ordn-en	[ɔɐtnən]	'order (verb)'

If, as the linguists listed above assume, the application of Final Devoicing is indicative of the parsing V:C.CV, then examples like the ones in (39) violate the TMR. From a formal point of view, I account for these TMR violations by positing that for this variety of German *COMPLEX is ranked ahead of TMR. What is more, NOCODA cannot be ranked ahead of *COMPLEX, as in (38), but instead the reverse holds: *COMPLEX » NOCODA. These rankings are summarized in (40a) and illustrated with two candidates for the word *regnen* in the tableau in (40b). In this tableau I do not consider the constraints necessary to predict that /g/ is devoiced (=Final Devoicing).

(40a) * COMPLEX » NOCODA, TMR

(40b)

	*COMPLEX	NOCODA	TMR
→[ʀeː g.nən]		*	*
[ʀeː.gnən]	*!		

6.1.2 English

Consider now the following English words, all of which contain VCCV or V:CCV. As in the German examples in (36), the CC sequence in (41) exhibits a sonority rise.

(41a)	caprice	[kʰəpʰɹiːs]
	attract	[ətʰɹækt]
	acrue	[əkʰɹuː]
(41b)	atlas	[ætˀləs]
	catkin	[kʰætˀkɪn]
	acne	[ækˀni]

The words in (41) have been placed into two separate groups. In (41a) the adjacent C's, i.e. /pɹ tɹ kɹ/, occur word-initially (e.g. *price, trade, cry*) and in (41b) they do not, i.e. /tl tl kn/.

The allophones of /p t k/ provide evidence that the word-medial CC clusters in (41a) are syllable-initial (i.e. V.CCV) and the ones in (41b) are heterosyllabic (i.e. VC.CV or V:C.CV). Since /p t k/ are aspirated in (41a), they are syllable- (and foot-) initial. By contrast, /p t k/ are glottalized in (41b), indicating that they are syllable-final. Recall from §3.2 that Glottalization is uncontroversially considered to apply in coda position. The data in (41b) are significant because they differ from the corresponding German examples in (36b), in which phonological evidence (i.e. the nonapplication of Final Devoicing) suggests the parsing V:.CCV.

English words like the ones in (41a) are correctly parsed as V.CCV with the ranking SSG » NoCoda » *Complex that was established in (38a) for German. This is illustrated in tableau (42a), in which three candidates for the word *acrue* are evaluated. English words like the ones in (41b) are parsed as VC.CV or V:C.CV with the language-specific ranking SSG, LOI » NoCoda » *Complex. This is shown in the tableau in (42b), in which two candidates for the word *atlas* are evaluated. In both tableaus I ignore the surface allophones of voiceless stops.

(42a)

	SSG	NoCoda	*Complex
→[ə.kɹu:]			*
[ək.ɹu:]		*!	
[əkɹ.u:]	*!	*!	

(42b)

	SSG	LOI	NoCoda	*Complex
→[æt.ləs]			**	
[æ.tləs]		*!	*	*

A number of linguists (see below) have noted that in English syllabification is crucially dependent on whether or not the vowel before one or more C's is stressed or unstressed. In words like the ones in (41a) the syllable preceding the two C's is unstressed, in which case most researchers agree that the two C's are situated in the following onset, i.e. V:.CCV. By contrast, when the first vowel is stressed, as in (43), phonologists either assume that the first C is ambisyllabic (see Kahn 1976, Gussenhoven 1986), or that it is in absolute syllable-final position (see Selkirk 1982, Hammond 1999):

(43) apron [eɪpɹən]
patron [pʰeɪtɹən]
cobra [kʰoʊbɹə]

I reject the proposed syllabification V:C.CV in such words because a phonological argument from English suggests that the first C not be syllable-final: Evidence against the parsing V:C.CV is that the first C is not glottalized, i.e. *[pʰeɪtˀ.ɹən]. Instead, I follow Kahn (1976) and Gussenhoven (1986) in analyzing the first of the two adjacent C's in words like the ones in (43) as ambisyllabic. The ambisyllabic representation for the words in (43) does not violate the TMR because the ambisyllabic C is not dominated by its own mora. For example, the [p] in *apron* is linked to the second of the two moras that dominate the long vowel and not to a third mora.

Accounting for the syllabification of the English data in (41) in an OT-based approach is a relatively simple matter, as shown in the rankings and tableaux in (42) above. By contrast, it remains to be shown how ambisyllabic consonants in examples like the ones in (43) can be predicted to occur given surface constraints. I leave open the question of how such constraints should be stated formally.

6.2 Syllabification of V:CjV

The German words in (44) contain a sequence of V:CjV. In (44a) the C in this string is an obstruent and in (44b) it is /ʀ/, which undergoes r-Vocalization to [ɐ]. The transcriptions in (44) are based on *Duden* (Drosdowski et al. 1990): [25]

(44a)	Studium	[ʃtuː.djʊm]	'studies'
	Radio	[ʀaː.djo]	'radio'
(44b)	Orient	[oːɐ.jɛnt]	'orient'
	Ferien	[feːɐ.jɛn]	'vacation'
	Karies	[kaːɐ.jəs]	'cavity'
	Bakterie	[bak.teːɐ.jə]	'bakteria'

Vater (1992) notes that even the pronounciation dictionaries cannot agree on whether or not the *i* in words like the ones in (44b) is to be pronounced as a glide (transcribed here as [j]) or a vowel (=[i]). According to Drosdowski et al. (1990) the *i* in (44b) (and (44a)) is a glide and not a vowel. By contrast, Krech et al. (1982) transcribe the *i* in the words in (44a) as a glide and the ones in (44b) as [i] and write explicitly that *i* in the latter words is pronounced as a vowel (p. 32). In the first part of this section I account for the data in (44) and in the second part I analyze the data in Krech et al. (1982).

Consider first the examples in (44a). In all of these words the pre-[j] consonant is a voiced. Since this sound does not undergo Final Devoicing we can safely conclude that it is situated in the onset. Hence, a word like *Studium* is syllabified [ʃtuː.djʊm] and not [ʃtuːd.jʊm], and since the first syllable is open, this parsing does not violate the TMR. The parsing Vː.CjV falls out from the ranking SSG » NoCoda » *Complex, which was established on the basis of the data in (36) and illustrated in the tableau in (38a).[26]

[25] Some of the studies devoted to the distribution of German glides include Moulton (1962), Klocke (1982), Vater (1992), Hall (1992) and Wiese (1996). None of these linguists propose an analysis for German glides that is akin to the one presented in this section.

[26] Recall from (39) that certain varieties of German have the option of syllabifying the first of two adjacent Cs in V(:)CCV in the coda of the first syllable. By contrast, this parsing is not possible for the examples in (44a), i.e. the pronunciation [ʃtuːtjʊm] is incorrect. I assume that forms such as [ʃtuːt.jʊm] are ruled out by virtue of the fact that they pose worse violations to the Syllable Contact Law (see Murray & Vennemann 1983 and Vennemann 1988) than forms like [ʀeːk.nən] (for *regnen*). I do not pursue this possibility here and simply leave it open for further study.

An examination of the phonetic form of the examples in (44b) reveals that /R/ is vocalized. Since r-vocalization uncontroversially takes place in coda position (see the discussion after (23)) the implication is that these words are parsed /VR.jV/, e.g. /kaːR.jəs/ (=[kaːɐ.jəs]) and not /kaː.Rjəs/. Since the vocalized-R is preceded by a long vowel, the examples in (44b) are significant because they all violate the TMR.

The words in (44b) do not conform to the TMR because the latter constraint is outranked by a higher one barring syllable-initial [Rj]. Assuming the sonority hierarchy in (35b), [Rj] cannot occur in syllable-initial position because the two segments are too close together on this scale (see Vennemann 1988: 44 for discussion on the avoidance of syllable-initial [r]+glide in Germanic); hence, the constraint barring syllable-initial [Rj] can be thought of as being a consequence of the constraint in (45a), which I call MINIMAL SONORITY DISTANCE (MSD) (see Selkirk 1984 for a pre-OT treatments of minimal sonority distance requirements in English). For purposes of this article I assume that the MSD refers specifically to [Rj]:

(45a) MSD: [Rj] is a nonoccurring onset

(45b) MSD » TMR

Given the language-specific ranking for German in (45b) the correct output forms in (44b) can be obtained. This is illustrated in the following tableau for *Karies*:

(46)

	MSD	TMR
→[kaːR.jəs]		*
[kaː.Rjəs]	*!	

That 'R' in the winning candidate in (46) is phonetically [ɐ] is accomplished with additional constraints that do not concern us here.[27] [28]

According to Krech et al. (1982: 32) the *i* after /R/ is predictably [i] or [j], depending on the location of word stress. When the syllable before /R/ is stressed, then [i] surfaces, as in (47a) below. By contrast, when the vowel following *i* is stressed, *i* surfaces as [j], as in (47b):[29]

[27] German also has words containing V:CjV where the C is a lateral or a nasal, e.g. *Familie* [famiːljə] 'family', *Linie* [liːnjə] 'line'. It is unclear whether or not [l] and [n] in these and similar words are syllable-initial or syllable-final. If the latter parsing is correct then this would suggest that the MSD be reformalized as a constraint barring onsets consisting of a sonorant consonant followed by [j]. If [l] and [n] are syllable-initial then the MSD in (45a) is correct and the parsing V:.CjV, where C is a liquid or nasal, is a consequence of the ranking in (38a).

[28] One cannot predict that [kaːR.jəs] is better than [kaː.Rjəs]] with the ranking *COMPLEX » NOCODA because German requires the opposite ranking of these two constraints (see (37b) and (38a)).

[29] See also Drosdowski et al (1990: 35): „Vor unbetontem Vokal wird [i] nach [r] nicht so leicht unsilbisch wie vor betontem Vokal....".

(47a)	Orient	[ˈoːʀiɛnt]	'orient'
	Ferien	[ˈfeːʀiɛn]	'vacation'
	Karies	[ˈkaːʀiəs]	'cavity'
	Bakterie	[bakˈteːʀi.ə]	'bakteria'
(47b)	äquatorial	[ɛkvatoɐˈjaːl]	'equatorial'
	bakteriell	[bakteɐˈjɛl]	'bakterial'
	kurios	[kuɐˈjoːs]	'curious'

The curious stress condition only makes sense when one considers the length of the vowel preceding /ʀ/. A number of writers have observed that German has long tense vowels like [iː uː eː] as well as short tense vowels like [i u e] which are in complementary distribution: The long vowels surface when stressed and the short ones when unstressed (see Reis 1974, Ramers 1988, Wiese 1988, Hall 1992, Wiese 1996). Examples can be gleaned from the words in (47). In (47a) the stressed vowels are all long and tense and in (47b) the unstressed vowels preceding /ʀ/ are short. If 'short' and 'long' translate into single and bimoraic structures respectively, we see that the reason /ʀ/ can be syllabified into the coda in (47b) (and subsequently undergo r-Vocalization) is that this segment is preceded by a monomoraic syllable. By contrast, /ʀ/ in (47a) cannot be syllabified into the coda because this segment is preceded by a bimoraic syllable. Put differently, the data in (47) show that for Krech et al. (1982) the TMR and the MSD are equally ranked.[30]

6.3 Exceptional moraic structure

As pointed out by Borowsky (1986, 1989), syllable-final sequences in English like VCC and V:C can violate her equivalent of the TMR when the final C or CC satisfy certain requirements (made specific below) concerning the place of articulation. In the following paragraphs I present an alternative account of such morpheme-internal sequences as being exceptionally bimoraic.

The underlined strings in the English words in (48) all appear to violate the TMR, since they are all pword-internal. In all of these examples the underlined string consists of a short vowel + nasal + homorganic stop, which I abbreviate henceforth as VNS. These words consist of monomorphemic and polymorphemic words.

(48)	e<u>mp</u>ty	ext<u>inc</u>tion
	p<u>ump</u>kin	inst<u>inc</u>tive
	b<u>ump</u>kin	ramb<u>unc</u>tious
	sph<u>inc</u>ter	b<u>ump</u>tious

[30] In V:CjV sequences in English, e.g. *union*, *chameleon*, the TMR would be violated given the parsing V:C.jV. I leave open how such words should be syllabified. Interestingly, there are no English words of the form V(:)ɹjV.

apopemptic	scrumptious
plankton	unctuous
symptom	puncture
handsome	assumption

Note that the segment following the VNS string in (48) is a stop or fricative. Although some English words contain a syllable-final VNS before a liquid or nasal, e.g. *antler*, *ointment*, I do not group together such examples with the ones in (48) for reasons to be made explicit below. Instead, I treat word with VNS followed by a sonorant as idiosyncratic exceptions to the TMR (see §6.6).

Equivalent German examples containing a pword-internal VNS followed by an obstruent have been presented in (49). As in English the underlined strings in the German words occur in both monomorphemes and polymorphemic words.[31]

(49)	Plankton	'plankton'	Adjunkte	'adjunkts'
	Symptom	'symptom'	disjunktiv	'disjunktive'
	Funktion	'function'	Punkte	'periods'
	Interpunktion	'punctuation'	distinkte	'distinct (nom. sg. fem.)'
	Disjunktion	'disjunction'	Instinkte	'instinkts'
	Sanktion	'sanction'	prompte	'prompt (nom. sg. fem.)'

Apparently there are no German words like *antler* and *ointment* in which the segment following a syllable-final VNS is a nasal or a liquid.

I account for the data in (48) and (49) by analyzing the underlined strings as exceptionally bimoraic. This is accomplished with the constraint in (50a), which I call VNS.

(50a) VNS: A syllable-final VNS is parsed as bimoraic if an obstruent follows.
(50b) VNS » 3-μ

The VNS is crucially ranked ahead of 3-μ (recall (11aii)), as shown in (50b) — a ranking that ensures that a syllable-final VNS sequence is parsed as bimoraic rather than trimoraic.[32]

[31] Note that the obstruent after VNS in the words in (49) is an anterior coronal, i.e. [t t͡s]. That labial, velar and postalveolar obstruents are nonoccurring in this context is a consequence of a general phonotactic constraint ensuring that the second of two adjacent (intervocalic) obstruents is an anterior coronal, i.e. sequences like [VkpV] and [VpkV] are nonoccurring. The same generalization holds for English, although there are some exceptions, e.g. *napkin*.

[32] Recall from note 6 that I analyze English [oːɹ] as exceptionally bimoraic, since this sequence can be followed by noncoronal obstruents in word-final position, e.g. *fork, absorb, born*. Given this treatment it is not surprising that [oːɹ] can surface within a pword in apparent violation of the TMR, e.g. *morning*, *orgy*, *Mormon*.

Interestingly, there is a strong tendency to delete the S in VNS precicely in the context in (50a), i.e. before an obstruent, when S shares the same place features with a preceding nasal. For example, a word like *empty* can be pronounced [ɛmpti] or [ɛmti] (see Borowsky 1989: 161). Several authors have noted that the post-sonorant stop in German examples like the ones in (49) can optionally delete as well (see, for example, Hall 1992: 117-118). Indeed, the optional deletion of the S in VNS before an obstruent is the reason why I do not consider words like *antler* and *ointment* to belong in (48).

The underlined strings in English words like the ones in (51) also appear to violate the TMR (see Borowsky 1986, 1989 who makes this observation). Monomorphemes have been presented in (51a) and stem + vowel-initial suffixes in (51b). The examples in (51) are all similar in the sense that the final consonant of the underlined strings shares the same place of articulation with the following consonant; thus, sequences like [e:m] and [e:n] are followed by [b] and [d] respectively. I refer to the underlined strings in (51) henceforth as V:N.

(51a)	dainty	bounty	boulder	(51b)	paint-ing
	laundry	mountain	shoulder		find-ing
	foundry	poinsettia	cauldron		sound-ed
	scoundrel	poinciana	holster		hold-ing
	bounteous		bolster		
	chamber		poultry		
	cambric		smoulder		
	maintain		doldrums		

The data in (51) reveal that the consonant following V:N is a homorganic obstruent.[33]

A comparison of the English examples in (51) with the German forms in (52) reveals a significant difference between the two languages. While there are many monomorphemic English words like the ones in (51a), corresponding German examples are nonoccurring. By contrast, German permits heteromorphemic words like the ones in (52), in which the final nasal in the underlined string is homorganic with the following stop:

(52)	Freund-e	'friends'
	Mond-e	'moons'
	Feind-e	'enemies'
	Fahnd-ung	'search'

[33] Borowsky (1989) considers words like *ancient, danger* and *angel* to belong to the examples in (51) as well. The status of the V:N strings in such words is not clear because the sound that follows [n] is postalveolar, i.e. [t͡ʃ d͡ʒ], and hence not homorganic with the preceding [n].

In the remainder of this section I concentrate only on the English examples in (51) and return to the corresponding German words in (52) in the following section.

I propose the constraint in (53a), which ensures that V:N is parsed as bimoraic when the N shares the same place node as the following obstruent:

(53a) V:N: A syllable-final V:N is parsed as bimoraic if an obstruent follows that is homorganic with N.

(53b) V:N » 3-μ

The language-specific ranking in (53a) ensures that a string V:N in words like *chamber* is parsed as bimoraic and not trimoraic.

Borowsky (1986, 1989) argues that the underlined strings in English words like *chamber* in (51a) (as well as (48)) can be explained by appealing to Hayes' (1986) Linking Constraint. Specifically, she argues that her equivalent of the TMR makes reference to a single line of association between the root node and the place node. Since the N and following C in (51) all share the place node, there exists a multiple link between two root nodes and a single place node and the Linking Constraint predicts that the relevant constraint should not hold. The upshot is that Borowsky's treatment allows morpheme-internal strings like V:N in words like *chamber* since they do not violate her constraint.

The problem with Borowsky's solution is that she employs the Linking Constraint as a diacritic. As pointed out by Hayes (1986) the Linking Constraint can only be invoked to block a constraint (or rule) if there exists an independent reason for formalizing it with a single line of association between the relevant tiers. I reject Borowsky's analysis because there is no such independent motivation for requiring that the TMR (or Borowsky's equivalent thereof) refer to a line of association between the root and place nodes.

6.4 Morphologically related words

An additional set of systematic counterexamples to the TMR are the German words in the first column of (54) (see also (52)). Note that all of these German examples are heteromorphemic and that the underlined string occurs in the stem. In (54a) the final segment in the underlined trimoraic syllable is a nasal (=[n]) that is homorganic with the following stop or fricative. By contrast, in (54b) the final consonant of the underlined sequence is not homorganic with the following consonant. All of the stem + suffix sequences in (54) are parsed as single pwords by (2iii) because the suffix is vowel-initial.

	derived word	*stem*	
(54a)	Mond-e	Mond	'moons'
	Freund-e	Freund	'friends'
	Freund-in	Freund	'female friend'
	sich an-freund-en	Freund	'make friends'
	Feind-e	Feind	'enemies'
	An-feind-ung	Feind	'hostility'
	sich ver-feind-en	Feind	'become enemies'
	Fahnd-ung	fahnd-	'search (noun)'
	fahnd-en	fahnd-	'search (inf.)'
	einst-ig	einst	'once'
	ernst-e	ernst	'serious'
	Ernte	ernt-	'harvest
	Dienst-es	Dienst	'service'
(54b)	Obst-es	Obst	'fruit'
	nächst-e	nächst	'next'
	Markt-es	Markt	'market'
	Häupt-e	Haupt	'chief'
	feucht-e	feucht	'damp'
	leicht-e	leicht	'light'
	feilsch-en	feilsch-	'bargain (verb)'
	fürcht-en	Furcht	'fear'
	beicht-en	beicht-	'confess'
	leucht-en	leucht-	'shine'
	jauchz-en	jauchz-	'shout for joy'
	rülps-en	rülps-	'burp'
	seufz-en	seufz-	'sigh'
	verleumd-en	verleumd-	'slander'

One cannot invoke the constraint V:N posited in (53a) to account for the German examples in (54a) for two reasons. First, this approach would not explain the absence of German monomorphemes like *chamber*, and second, it would fail to account for the existence of TMR violations in the underlined strings in (54b).

The reason the underlined sequences in (54) are systematic counterexamples to the TMR is that they are all the derived forms of the corresponding stems. In all of the bare stems in (54) the identical segment structure is preserved in the derived forms; hence, the data in (54) illustrate 'paradigm uniformity'.[34] Put differently, the reason the underlined strings in (54) violate the TMR is that there is pressure to avoid allomorphy by keeping the paradigms intact.[35] Formally I adopt the constraint LEVEL in (55a) (from Raffelsiefen 1995: 28ff.). In contrast to pinut-output faithfulness consitraints, e.g. MAX-IO and DEP-IO, LEVEL compares the *surface* forms in a paradigm.

(55a) LEVEL: All members of a paradigm must have identical forms.
(55b) MAX-μ: No deletion of a mora.
(55c) MAX-μ » TMR, LEVEL

In addition to LEVEL my analysis requires the faithfulness constraint MAX-μ in (55b), which penalizes any output form in which an underlying mora has been deleted. Given the ranking for German in (55c) the violations to the TMR in (54) can all be accounted for, as I demonstrate below.

Let us consider the pair {*Obst, Obstes*} as a representative example of a 'paradigm' in (54). Four possible paradigms (or, 'candidate sets') are presented in (56), which differ in terms of the length of the initial vowel. In (56) and below the moraic structure is assumed to be a function of the corresponding segment structure; hence, the stem syllable in all eight phonetic forms are trimoraic. MAX-μ violations are determined by comparing the length of the vowel in both the nonderived form and the derived form with the (bimoraic) /oː/ in the underlying form /oːpst/.

(56)	A	B	C	D
	$([.\text{oːpst.}])_\omega$	$([.\text{oːpst.}])_\omega$	$([.\text{ɔpst.}])_\omega$	$([.\text{ɔpst.}])_\omega$
	$([.\text{oːp.stəs.}])_\omega$	$([.\text{ɔp.stəs.}])_\omega$	$([.\text{oːp.stəs.}])_\omega$	$([.\text{ɔp.stəs.}])_\omega$

Compare first the winner A with candidate sets B and C. While A violates the TMR once (in [.oːp.stəs.]), it is completely faithful to LEVEL and to MAX-μ. By contrast, the candidate sets in B and C reveal that LEVEL and MAX-μ are violated once. Consider now the tableau in (57). The reason MAX-μ (and not LEVEL) is ranked crucially ahead of TMR can be deduced by examining candidate set D. Here LEVEL and TMR are satisfied, but MAX-μ is violated twice:

[34] By 'identical stem structure' I mean specifically vowel and consonant length. For example, a stem ending in V:CC preserves V:CC when a suffix is added.

[35] Some of the recent literature on the role of paradigm uniformity in phonology includes Raffelsiefen (1995), Kenstowicz (1996), Benua (1997), and Steriade (1999). See also Kager (1999: chapter 4) for a synthesis on the recent literature on this topic. Paradigm uniformity has enjoyed a long tradition in linguistics. For earlier studies see Kuryłowicz (1949) and Kiparsky (1982).

(57)

	MAX-μ	LEVEL	TMR
→A			*
B	*!	*	
C	*!	*	*
D	*!*		

A final remark needs to be made concerning the words in (54). In some of these examples we see stem alternations, e.g. in the pair {*Mond, Mondes*} in (54a) the bare stem is pronounced [moːnt] but as [moːnd] with the suffix *–es*. In (54b) we see that in the paradigm {*Haupt, Häupt-e*} only the latter stem exhibits Umlaut of the stem vowel. What these examples tell us is that LEVEL is dominated by other constraints that allow for allomorphy. I do not present a formal analysis of these examples here, since it would detract from the main issues dealt with in the present paper. Let us simply posit that constraints necessary to account for Final Devoicing and other alternations must be higher ranked than TMR.[36]

6.5 Prosodic compounds

In this section I discuss German and English words in which a trimoraic syllable surfaces within a polysyllabic morpheme. I argue that such morphemes should be analyzed as prosodic compounds, i.e. they are identical to compound words in terms of prosodic but not morphological structure. In contrast to the examples discussed in §6.1-§6.4, the prosodic structures I posit below do not fall out from constraint rankings, but instead derive historical motivation.

The underlined sequences in the monomorphemic German words in the first column of (58) appear to violate the TMR. In (58) and below MHG = Middle High German.

(58)	<u>Ant</u>wort	MHG antwürte	'answer'
	<u>Ant</u>litz	MHG antlitze	'face'
	<u>Ur</u>laub	MHG urloup	'vacation'
	<u>Ur</u>sprung	MHG ursprunc	'cause'

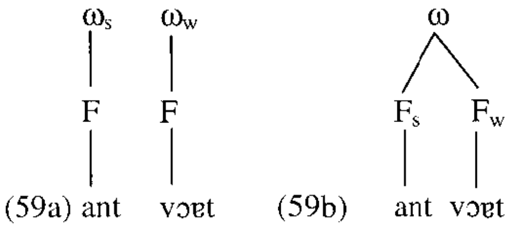
The existence of a trimoraic structure internal to a morpheme in the examples in (58) has the same explanation: These words are historically of the form prefix + stem, where the underlined portion subsumes the moraic structure of the prefix. Consider first *Antwort* and *Antlitz*. The *Ant-* in both of these forms is historically the (primarily stressed) prefix *ant-*, which, in the vast majority of other German words which contained it, reduced to *ent-*, c.f. *entfernt* 'distant' in (33), in which the stem and not the prefix is stressed. By contrast, the *Ant-* in the

[36] In German there is to my knowledge one example of a morpheme containing a long vowel in the underived form, namely *Polen* [poː.lən] 'Poland', which is shortened upon suffixation, cf. *poln-isch* [pɔl.nɪʃ] 'Polish'. Since this is the only example of a morpheme violating LEVEL, I assume it is a lexically listed exception.

first two words in (58) retained its stress and therefore did not reduce. In Modern Standard German the earlier morphological structure is completely opaque; hence the words *Antwort* and *Antlitz* are perceived as monomorphemic. The same generalization pertains to *Urlaub* and *Ursprung*, both of which contain the historical prefix *Ur-*, but which are perceived as monomorphemes.[37]

I analyze the examples in (58) as prosodic compounds, i.e. as words that are analyzed as compound words from the point of view of prosodic structure and not morphological structure.[38] Put differently, all of the words in (58) are monomorphemes from the point of view of morphology, but the prosodic structure is the same as in true prefix + stem forms in which the prefix is stressed (see (32a)). Thus, in the development from MHG to Modern Standard German the morphological structure changed but the prosodic structure remained intact.

Let us now consider the nature of the prosodic representations for the words in (58), in particular foot- and pword-structure. With respect to the former constituent, one could either say the examples in (58) are dominated by (i) a single trochaic foot, or (ii) two separate monosyllabic feet. I adopt (ii) and reject (i) because only the former but not the latter can account for the fact that the words in (58) are stressed like compounds (e.g. *Bahnhof*) and prefix + stem words where the prefix is stressed, e.g. *Aufstieg*. In other words, the second syllable in the Modern German words in (58) bears secondary stress. In order to capture the generalization that the first foot in words like *Antwort* is strong (=primary stress) and the second weak (=secondary stress) the first pword is labeled s (=strong) and the second one w (=weak) (recall prefixed words like *Aufstieg* in (32a)). Taking the pword into consideration, there are two possible representations, i.e. (59a) and (59b), for the examples in (58). I hold that (59a) is correct for the words in (58) but that other German (and English) words discussed below require the structure in (59b).



The analysis presented in the preceding sections provides two reasons for (59a) and against (59b). First, the first syllable in (59b) but not (59a) violates the TMR. Second, the rule

[37] Modern German still retains the productive prefix *Ur-*, e.g. *Uroma* 'great-grandma'.

[38] See also Becker (1996: 276-278), who considers German words like the ones in (58), as well as proper names to be *Scheinkomposita*, i.e. words that are prosodically but not morphologically compounds. However, Becker does not say explicitly how such examples should be represented prosodically in terms of feet and pwords. Raffelsiefen (2000: 45) argues similarly that certain words, e.g. *Abenteuer* 'adventure' that were etymologically never compounds are 'pseudo-compounds'; i. e. grammatical words composed of more than one pword.

referred to in §5 which predicts that the prefix in prefix + stem is primarily stressed is correctly satisfied only in (59a) but not in (59b) (recall that this constraint refers to two adjacent pwords).[39]

Note that the pwords in representation (59a) cannot be predicted based on the algorithm presented in (2). The reason *ant-* and *Ur-* as well as the elements to which they attach in (59) cannot be parsed as pwords is that these sequences of sounds are neither stems marked for a lexical category, nor (stressed) prefixes. That *ant-* and *Ur-* are historical prefixes is not a part of the competence of native speakers, but the prefixal nature of *ant-* and *Ur-* is captured in the prosodic structure alone. Since (2) cannot correctly parse *ant-* and *Ur-* as a pword, the pwords in representations like the one in (59a) are underlying.

Borowsky (1986, 1989) notes that her equivalent of the TMR does not govern proper nouns like the ones in (60). If these items are monomorphemic words (=single pwords), then they violate the TMR:

(60)	Elmhurst	Siegmund
	Kingsley	Kleinhenz
	Grimsby	Bernhard
	Greenberg	Salzburg

I analyze names like the ones in (60) as prosodic compounds, i.e. (59a) is the correct representation. This structure is supported by the fact that the stress pattern of the names in (60) is identical to the stress pattern of compound words with primary stress on the first constituent, e.g. MSG *Bahnhof* 'train station' [ˈban.ˌhoːf]. In fact, some of the names in (60) are obviously compounds, e.g. *Salzburg*. It is also significant that names like the ones in (60) behave as two pwords in other respects. For example, one property shared by proper names and compounds in German is that they allow a sequence of [tk], e.g. *Bratkartoffeln* 'fried potatoes', *Edgar*, whereas this sequence is ruled out morpheme-internally. Examples of

[39] See also Booij (1999: 59-60), who argues that certain Dutch words have the representation (59a). Giegerich (1985: 77ff.) analyzes words like the ones in (58) as *morphological* compounds in order to explain why the first syllable and not the final one is stressed. The present treatment captures the generalization that these words behave phonologically as two words but morphologically as one.

Additional examples of German and English words in which the TMR is violated in a bound stem include certain days of the week, as in (i) and (ii):

(i)	Montag	'Monday'	(ii)	Tuesday
	Dienstag	'Tuesday'		Wednesday
	Samstag	'Saturday'		

That the second part of the examples in (i) and (ii) (i.e. *–tag* and *–day*) bears secondary stress implies that these words consist of two separate feet. I assume that the correct prosodic structure for these examples is (59a), in which case the underlined strings in (i) and (ii) do not violate the TMR. This analysis is supported by the etymology of the respective stems, which were all once free morphemes corresponding to the names of Germanic gods.

phonological generalizations in English that do not hold for proper names are discussed in Raffelsiefen (1993: 90-92).[40]

Additional examples of words that appear to violate the TMR have been listed in (61):

(61a)	Kaninchen	'rabbit'	(61b)	grateful
	Mädchen	'girl'		ruthless
	Radieschen	'raddish'		armlet
	Kürschner	'furrier'		
	Hälfte	'half'		

The examples in (61) are similar in the sense that they contain a 'bound root' plus a 'suffix'. Two typical examples are the words *Kaninchen* and *Mädchen* in (61a). These items are synchronically monomorphemic but they were once heteromorphemic, i.e. MHG *kanīnchen* meant 'rabbit (dim.)', which was formed productively from the noun *kanīn* 'rabbit'. The latter word eventually dropped out of the language, at which point the meaning of *Kaninchen* became lexicalized. *Mädchen* similarly derives from Early New High German (ENHG) *Mägdchen* 'maiden (dim.)'on the basis of the stem *Magd* 'maiden'. If the TMR has been active since MHG then MHG *Kaninchen* and ENHG *Mägdchen* were clearly not exceptions to the TMR. The first part of the English words in (61b) was similarly at one point in the history of English an occurring free form (*grate* < Latin *grātus* 'agreeable'; *ruth-* < Middle English *rewthe* 'remorse').

Although the morphological boundaries in (61) were lost, the prosodic structure was retained. Thus, in Modern Standard German and Modern English the pword structure of the examples in (61) is as in (62). Note that these representations are identical to the ones posited earlier for true stem + suffix sequences in which the suffix contains a reduced vowel (see (31d)).

(62a)	(Kanin)$_{\omega}$chen	(62b)	(grate)$_{\omega}$ful
	(Mäd)$_{\omega}$chen		(ruth)$_{\omega}$less
	(Radies)$_{\omega}$chen		(arm)$_{\omega}$let
	(Kürsch)$_{\omega}$ner		
	(Hälf)$_{\omega}$te		

Since the 'bound roots' in (62) are not true morphological stems that are marked for lexical category membership, I assume that the pword structure in (62) is underlying.

[40] Other proper names cannot be represented prosodically as in (59a) because the second syllable contains a reduced vowel, e.g. *Ruhnke* [ʀuːn.kə], and *Dresden* [dʀeːs.dən]. I assume that examples like these are represented as in (62) below.

The words in (58) and (60) show that it is possible for the morphological sructure to become opaque historically but that the pword (and foot) structure remains intact. In contrast to the examples in (58) and (60), many words in German and English have undergone both a morphological *and* a prosodic restructuring. Examples of historical compound words that have restructured to single pwords are listed in (63) (from Raffelsiefen 1993, 1999a, Booij 1999):

(63)	business	postman
	cupboard	shepherd
	breakfast	

A comparison of the phonetic representation of the words in (63) with the phonetic form of the words from which they derive indicates that the prosodic restructuring triggered various segmental processes, e.g. the deletion of [i] in *business*, the reduction of [pb] to [b] in *cupboard*, the reduction of unstressed vowels to schwa in *breakfast*, *postman* and *shepherd*.

The German examples in (64) underwent a restructuring or pwords as in the English examples in (63):

(64)	Himbeere	MHG hintber	'rasberry'
	Brombeere	MHG brāmber	'blackberry'

These words are etymologically compounds; in contrast to MSG, the first part of *hintber* and *brāmber* were attested in MHG as free morphemes, i.e. MHG *hinde*, MSG 'Hirschkuh', MHG *brāme* MSG 'Dornstrauch'. If, as suggested above, the TMR were active in MHG, then these original compounds had the pword structure in the first column of (65). I assume that the loss of *hinde* and *brāme* as free morphemes meant that the first part of the original compounds could not be parsed as a pword, since *hinde* and *brāme* had lost their status as stems marked for a lexical category. Since the trimoraic syllables violated the TMR they were subsequently shortened.[41]

(65)	$(\text{hint})_\omega(\text{ber})_\omega$	$(\text{Himbeere})_\omega$	'rasberry'
	$(\text{brām})_\omega$ $(\text{ber})_\omega$	$(\text{Brombeere})_\omega$	'blackberry'

There is, however, an important difference between the prosodic restructuring that occurred in the English examples in (64) and in the Modern German ones in (65): The former words are composed of a single pword and a single (trochaic) foot, whereas the Modern German

[41] Clearly, one needs to account for why the prosodic restructuring as in (65) occurred in these examples but not in others. For example, the prosodic structure of the days of the week (see note 39) were not restructured into single pwords. In this particular case I assume that the prosodic structure in the days of the week was retained because these are highly frequent words.

examples in (65) consist of a single pword and two feet. Thus, the representation in (59b) above is the correct one for MSG words like *Himbeere* and *Brombeere*.

6.6. Idiosyncratic exceptions

The following is a list of German and English words in which the underlined sequences violate the TMR. Since none of these words can be grouped together with any of the systematic counterexamples discussed in §6.1-§6.4, I refer henceforth to these words as idiosyncratic exceptions to the TMR. The English examples are all of the ones presented in Borowsky (1986, 1989) that I cannot otherwise explain, as well as some examples of my own. I make no claims concerning the completeness of the list in (66).

(66)	Partner	'partner'	partner	polka
	Skulptur	'sculpture'	sculpture	harpsichord
	arktisch	'arctic'	arctic	infarction
	Erde	'earth'	seismic	beatnik
	Halfter	'holster'	deictic	antler
	Auktion	'auction'	auction	ointment
	Börse	'stock exange'	apartment	
	Leutnant	'lieutenant'	compartment	
	Müsli	'Müsli'	department	

In light of the hundreds of thousands of trimoraic syllables in German and English that occur uncontroversially at the end of a pword, it is certainly noteworthy that the number of idiosyncratic exceptions in both languages is remarkably small. This point aside, there are three additional reasons why the words in (66) are interesting.

First, at least one of the trimoraic sequences in (66) is otherwise nonoccurring in the language as a whole, namely the German word *Skulptur*, which is apparently the only example of a word containing a syllable ending in [ʊlp]. Second, three of the trimoraic syllables in (66) are unstable and therefore tend to shorten, namely *arctic* and *polka*, and *Börse*. Borowsky (1986, 1989) notes that the [k] in the English word *arctic* tends to be elided in everyday speech; the same can be said for the [l] in *polka*. Both Krech et al. (1982) and Drosdowski et al. (1995) note that the long vowel [øː] in *Börse* can optionally be pronounced as [œ]. Third, some of the underlined strings in (66) might not be trimoraic syllables to begin with if the final consonant were syllabified into the following onset, as opposed to the coda, which I assumed in (66), i.e. Modern German *Müsli*, *Leutnant*, *Partner* might be syllabified *Mü.sli*, *Leu.tnant* and *Par.tner* respectively. Interestingly, the analysis of German syllabification in §6.1 predicts the latter syllabification.

7 Conclusion

The cental thesis put forth in the present article is that in both German and English there is a constraint I call TMR that limits trimoraic rhymes to the final position in a pword. A second claim is that the TMR is violated in both languages in certain (predictable) cases and that these facts can be explained by ranking various markedness constraints ahead of the TMR in an OT framework.

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Weak position constraints: the role of prosodic templates in contrast distribution*

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0 Introduction

Surveys of lenition processes (recent examples include Kirchner 1998, Lavoie 1996) have shown that medial positions are a predominant weakening environment in the languages of the world. Intervocalic position, a subset of medial positions, is widely assumed to be the most common site of phonetic and phonological "reductions" or lenition, such as voicing, spirantization, and sonorization of obstruents, as exemplified in (1a, b). Further processes generally classified as lenition include degemination (e.g. tt → t), deaspiration (e.g. th → t), debuccalization (e.g. t → ʔ), and even total deletion. Such changes are often assumed to follow a trajectory from the strongest or least sonorous consonants to the weakest or most sonorous, moving along a sonority or consonantal strength scale (cf. Hock 1991:83).

(1) Lenition processes (Hock 1991:81)

a. k, t → g, d → ɣ, ð
   Latin pacatum
      intervocalic stop voicing > *pagado
         spirantization > Spanish [paɣaðo]

b. t → d → y
   Sanskrit mata-
      intervocalic stop voicing > Middle Indo-Aryan (dialectal) mada-
         sonorization > dialectal maya

Though the phonetic motivations for shifts such as voicing and spirantization in intervocalic environment seem clear (cf. Kirchner 1998), when phonetic explanations are used to drive phonological accounts of lenition, they run afoul of contradictory data, namely, that this same putative lenition environment is also the canonical environment for the realization of geminate consonants, the "strongest" possible type of consonant, according to Hock's (1991) strength hierarchy. Harris (1998) has also noted this phonological contradiction in the occurrence of both lenited and geminate segments in medial positions, sometimes in the same language, and sees it as evidence against ambisyllabicity.

* My thanks to the following for their useful comments on this article and its precursors (names in alphabetical order): Tracy Alan Hall, Greg Iverson, Tom Purnell, and Joe Salmons. Any errors are solely the responsibility of the author.

Phonetic pressures affecting consonants in an intervocalic environment may certainly give rise independently to both strengthening and weakening of consonants, but the question of how these phonetic pressures might be phonologized remains open to debate. In a phonological study of strengthening and weakening processes, it seems rational to view "strengthening" and "weakening" not in terms of scalar values or phonetic universals, but rather as relative terms pertaining to the distribution of phonemic contrast in various environments, with corresponding elaboration or restriction of the phonetic expression of contrast. Strength hierarchies remain useful descriptors of changes relating to the phonetic expression of contrast, but the phonologist must be concerned with the systematic implementation of phonetic realizations within a given system. The goal, then, is to explain the motivations for the presence or absence of contrast as well as systematic alternations in the phonetic realizations of contrast.

While analyses of strengthening and weakening phenomena at the level of syllabic juncture (Vennemann 1988, for example) view medial position in terms of a syllabic nucleus/ coda and a following onset, syllabic approaches neglect the fact that syllable boundaries often fall entirely within higher levels of metrical structure such as the foot or prosodic word. Accordingly, the focus of this study is cases where realizations of certain consonants are conditioned by their position in a foot or prosodic word, with cases presented below in section 1.

I argue in this study that consonantal strength shifts can be explained through positional bans on features, expressed over positions marked as weak at a given level of prosodic structure, usually the metrical foot. This approach might be characterized as "templatic" in the sense it seeks to explain positional restrictions and distributional patterns relative to independently motivated, fixed prosodic elements. In this sense, it follows Dresher & Lahiri's (1991) idea of *metrical coherence* in phonological systems, namely, "[T]hat grammars adhere to syllabic templates and metrical patterns of limited types, and that these patterns persist across derivations and are available to a number of different processes..." (251).

The primary formal mechanism of this templatic view is phonological licensing, itself developed by Itô (1986) as a type of template matching that regulates syllable structure and phonotactics. The analysis presented here simply extends the notion of licensing beyond the syllable level, following, for example, Harris (1997, 1998) or Piggott (1999). Though the proposals presented here share much in common with Harris' work on similar topics, they disagree in a number of substantive points, particularly in the interpretation of privative features and in the syllabification of word-final consonants, but also in the characterization of the laryngeal distinctions of Danish and German. These points are discussed in sections 2 and 4.

A templatic approach, which accords a central role in segmental licensing to the metrical foot, further recognizes the existence of positions that are not explicitly marked as either strong or weak, suggesting that unfooted syllables (or "degenerate" feet) within a prosodic word, for example, will not be subject to the same sorts of positional restrictions that hold for "true" foot-medial onsets. Section 3 of this study examines the distribution of /h/ and aspiration in English as well as the process of *d*-weakening in Emsland German, finding that in some cases, non-prominent initial syllables, as well as syllables following trochaic feet within the same prosodic word, can show realizations of features that are not found foot-medially. Assuming that feet are maximally binary, such disjunctions can be explained quite simply if distributional constraints are assumed to hold only in syllables marked as weak within a metrical foot. Such distributions serve as a strong argument for the necessity of weak position constraints in explaining positional alternations.

The study is structured as follows: section 1 presents a typology of distributional asymmetries based on data from unrelated languages, demonstrating that the stress foot of each of these languages determines the contexts of neutralization and weakening of stops. Section 2 elaborates the notion of a template, exploring some of its formal properties, while section 3 presents templatic analyses of data from English and German. Section 4 explores the properties of weak positions, especially weak onsets, in more detail, including discussion of templates in phonological acquisition. Section 5 summarizes and concludes the study.

1 Strengthening and weakening in medial position

The following section, which exemplifies shifts in consonantal strength conditioned by position in the metrical foot, takes data from languages with a binary opposition in the laryngeal specification of their stop series. Lenition conditioned by trocahic feet is found in Danish (data following Harris 1997, 1998), and Husby German (hereafter Hus.G.), a Low German dialect spoken in Schleswig, near Germany's border with Denmark. Some of the primary phonological differences that Hus.G. shows relative to Standard German (Std.G.) are a lack of "final devoicing" and the reduction of certain medial stops. The consonantism of Hus.G. is quite similar to that of Danish, which allows for an easy comparison of distributional alternations. This study also investigates two languages with prosodically-conditioned lenition and iambic stress patterns, namely, Walpole Island Ottawa/Eastern Ojibwe[1] (Algonquian, spoken in southeastern Ontario), and Bannack[2] (Numic/Uto-Aztecan, spoken in Nevada).

[1] Walpole Island Ottawa (Odawa), as described by Bloomfield (1957), Holmer (1953), and Rhodes (1985), and Eastern Ojibwe belong to different dialect groupings. The two are nonetheless phonologically similar in many ways and for current purposes can be discussed together as one language.

[2] It is debatable whether Bannack indeed has iambic stress, since Liljeblad (1950) claims that it has no stress at all (as a tonal language). The distribution of "degrees of stress" he describes, however, is such that the initial syllable receives a lesser degree of stress than the syllable following it in a majority of cited forms, regardless of tonal qualities.

For the moment, the analysis is only concerned with the appearance of lenition in the canonical binary foot. Issues related to polysyllabic forms with degenerate feet, monosyllabic forms, and forms with atypical stress patterns will be addressed later. At this point, we turn to brief sketches of the plosive systems of each of the languages under consideration and specifically the distribution and phonetic realizations of plosive allophones.

1.1 Danish and Husby German

Following Iverson & Salmons' (1995) proposals on laryngeal features in Germanic, I will assume that laryngeal distinctions in Hus.G. and Danish are privative, characterized phonologically by the feature [spread glottis] rather than [voice] (i.e., /p/ is marked as [s.g.], thus actually /p^h/, while the other series, transcribed here as /b/, has no laryngeal specification). This is seen in the contrast of aspirated versus plain stops in word-initial syllables, for example, as opposed to unaspirated realizations in clusters, medially and finally. The lenis stops /b d g/, with no laryngeal specifications of their own, display laryngeal qualities ranging from fully voiceless to passively voiced throughout, depending on the surrounding environment. Initial and final environments tend to condition voicelessness, while medial and especially intervocalic environments promote voicing.

The lenis stops of both Danish and Hus.G. are subject to lenition in some positions. Harris (1998:9) argues that non-foot-initial position conditions reduction of Danish stops, shifting /b d g/ respectively to [w, ð/ɾ, j/w]. Danish non-initial /p, k/ are subject to ambient voicing between sonorants, with /t/ further subject to flapping. In Hus.G., /p t k/ are unaspirated except initially and can be voiced in non-foot-initial position. Contrast between the two plosive series of Hus.G. is neutralized in any syllable coda, though the realization there is lenis, rather than fortis as in Std.G. Furthermore, contrast between /p, k/ and /b, g/ is neutralized in medial onsets (again to the lenis realization), while /d/ has the allophone [ɾ] in this position. Thus, medial /t, d/ still contrast, though as [d, ɾ].[3] Examples of the variable realizations of stops in these two languages are presented in (2):

(2) LARYNGEAL DISTINCTIONS AND CONSONANT WEAKENINGS IN DANISH AND HUSBY GERMAN

	(foot-)initial syllable onset	(foot-)medial syllable onset	coda
Husby German (Germanic, trochaic) source: Bock (1933)	[t^{h}ain] "ten" <tain> [d̥e:b] "deep" <deeb>	[lo:dən] "to allow" <laten> [bro:ra] "brother" <brodar>	[dad] "that" <dat> [bre:d] "broad" <breed>
Danish (Germanic, trochaic) source: Harris (1997, 1998)	[p^h]il "arrow" <pil> [p]il "car" <bil>	næ[b]e "hardly" <næppe> e[b]e "low tide" <ebbe> pe[w]er "pepper" <peber>	la[p] "patch" la[p] "paw"

[3] Historically, some instances of /d/ were entirely lost, as in [bo:am] "floor, bottom," from Old Saxon *bodem*.

In both languages, medial onsets support contrast, albeit only in a limited number of cases, and then with a phonetically weakened implementation of the contrast relative to that found in initial position. Medial realizations of [spread glottis] are lacking in both languages, with neutralizations of /p, k/ and /b, g/ possible in Danish (and obligatory in Hus.G.). The same pattern of reduction and neutralization found in medial onsets holds for Danish codas, while Hus.G. allows no laryngeal distinctions there.

1.2 Eastern Ojibwe/Ottawa

Eastern Ojibwe dialects have iambic, rather than trochaic stress, but phonetic realizations of the fortis and lenis stop series in this linguistic grouping is quite similar to that of Hus.G. and Danish. The sources consulted (Bloomfield 1957, Holmer 1953 and Rhodes 1985[4]) do not entirely agree in their phonetic descriptions of the stops and their likely laryngeal characterization. Rhodes (1985) describes the /p, t, k/ of stressed medial onsets as aspirated and fortis. He disagrees with Bloomfield's description of word-initial stops, however, stating that word-initial /p t k/ are also aspirated and fortis, while Bloomfield states that only lenis stops appear initially. Thus, for Bloomfield, contrast between the two series is possible only intervocalically. Bloomfield also describes the medial fortes as pre-aspirated rather than post-aspirated.

Sources differ strongly in their characterizations of the lenis stop series, which I will transcribe here as /b d g/ for expository convenience. In Eastern Ojibwe, surface realizations of these stops range from voiceless in initial position to partially or fully voiced in intervocalic position and after nasals (Bloomfield 1957:8). Rhodes (1985:xxx-xxxi, xlii-xlvi) also states that lenis stops are realized as voiceless before heterorganic fortis stops (i.e., /bt/ is realized as [pt]) and deleted before homorganic fortis stops, except for /g/, which can be realized as a voiceless spirant before /k/ (e.g., [xk:]). The dialects also diverge as to the presence of final devoicing: Rhodes (1985:xxiv) notes that final devoicing is characteristic of Ottawa dialects but not of Eastern Ojibwe as a whole. Furthermore, Holmer (1953) notes that some postvocalic stops can spirantize, although it is not clear under precisely what conditions: lenes become fricatives between vowels, but only if the following vowel is not schwa, but some coda lenes are apparently also subject to spirantization. As the spirantization data are unclear, I will omit them from discussion but note their their potential to contradict the analysis presented here.

Positional distributions in Ojibwe are summarized in (3):

[4] Piggott (1980) was consulted after much of this article had been drafted; full consideration of his analysis of Odawa fortis obstruents as underlying geminates deserves discussion as well, but for reasons of length, such discussion is omitted from this version of my article.

(3) LARYNGEAL DISTINCTIONS AND CONSONANT WEAKENINGS IN OJIBWE

	(foot-)initial syllable onset	(foot-)medial syllable onset	coda
Ojibwe/Ottawa (Algonquian, iambic) source: H=Holmer 1953, B=Bloomfield 1957, R=Rhodes 1985	R:[p:ʰ]abid "to sit on s.t." vs. [b̥/p]aabiid "to wait" R: lenis C can be lost entirely in this position in some speech registers. B: no contrast initially: lenis only.	B: pe[k/g]a:na:kk "walnut tree," pe[ʰkk]a:nat "it is different"	R: Ottawa devoices phrase-final stops. B: pe:šekwa:pi:[k] "one string or row", pe:šekwa:pi[kk] "one dollar"

Ojibwe thus contrasts a series of stops marked as [spread glottis] with an underspecified series. As seen in the table above, the realization of the laryngeally unspecified series varies strongly by position, with Ottawa even allowing a spirantized realization postvocalically, even in stressed onsets. The underlying [spread glottis] specification, however, is always realized on the surface, albeit non-contrastively in codas, and to varying degrees in onset positions.

1.3 Bannack

The laryngeal distinctions of Bannack, the remaining language in this sample, are rather different from those of the languages discussed above. In initial position, Bannack stops are realized variably: they can appear either as stops (voiceless lenis or voiced), or as voiced spirants. Liljeblad (1950) states, however, that in initial position, these are "most often ... heard as a voiceless lenis stop" (130). There is a length and laryngeal distinction between two series in medial position, though. Medially, long and voiceless or glottalized stops contrasts with a series of stops that is always voiced, though sometimes either long or spirantized. Illustrated graphically, the range of realizations is as below, using labials as representative examples:

initial	*medial*
[p, b, β]	[b, β, b:]
	[pˀ, p:ˀ]

In Liljeblad's analysis, the free variation in glottalized versus voiceless realizations of the "strong" series in medial position only means that the laryngeal opposition between the two series is best characterized as ʔC versus C, which is neutralized in initial position to C. To be consistent with the privative feature analyses assumed for Danish, German and Ojibwe, the laryngeal distinctions of Bannack will be presumed here to derive from a privative [constricted glottis] specification. Sample data from Bannack are given in (4), where vowel diacritics indicate relative stress rather than tone.

(4) LARYNGEAL DISTINCTIONS AND CONSONANT WEAKENINGS IN BANNACK

	(foot-)initial syllable onset	**(foot-)medial syllable onset**	**coda**
Bannack (Numic/Uto-Aztecan, iambic) source: Liljeblad 1950	[pía], [bía], [βía] "woman"	[màk·á] -[màk ʼ·á] "to feed", [pàɣá] - [pàgá] - [pàg·á] "arrow"	n/a

As in the other languages described above, the laryngeally unspecified stops of Bannack are subject to allophonic reductions, while the marked feature [constricted glottis] is restricted in its appearance. The contrast between the two series of stops is realized in a maximal phonetic elaboration between long and glottalized [constricted glottis] stops versus voiced and potentially spirantized unmarked stops.

1.4 Summary of positional distributions across the metrical foot

In each of the languages discussed above, the ability of a given syllable to support contrast appears to be determined by the language's metrical foot: in Hus.G. and Danish, the distributional template for feature realization is a syllabic trochee, where the initial syllable is stressed and underlying laryngeal specifications fully realized. Thus, [spread glottis] stops are aspirated initially but lack aspiration medially. The medial onset position is subject to allophonic reduction, though contrasts between phonemic series may still be present: Hus.G. retains a contrast between coronal stops only, while Danish implements its contrast in medial position in terms of continuancy only. Across the iambic feet of Bannack, we see that initial onsets are subject to neutralization and allophonic reductions, while medial onsets preserve contrast between two series. In fact, seen in terms of strength scales, the contrasts found in Ojibwe and Bannack even appear exaggerated in medial position: phonemically marked series are long and have fully realized laryngeal gestures (i.e., strengthened), while the unmarked series can be subject to spirantization (i.e., weakened).

There is, in contrast, considerable variation in the realization of word-or phrase final stops: Hus.G. treats such stops as it does all codas and neutralizes distinctions, while Danish variably weakens or neutralizes stops in final position (laryngeal neutralization is found in phrase-final position, lenition in word or syllable-final position). In Ojibwe and Bannack, we observe the opposite distribution. When the initial syllable of the foot is weak, its onset can be subject to neutralization or deletion. While Bannack tolerates only [h] and [ʔ] as coda consonants and sheds no light on the licensing potential of codas in iambic languages, the two varieties of Ojibwe discussed demonstrate quite contrary possibilities. Eastern Ojibwe preserves a contrast between fortis and lenis elements in non-final codas, while Ottawa requires a fortis realization: in either case, the marked laryngeal feature [spread glottis] appears in this position, whether contrastively or not.

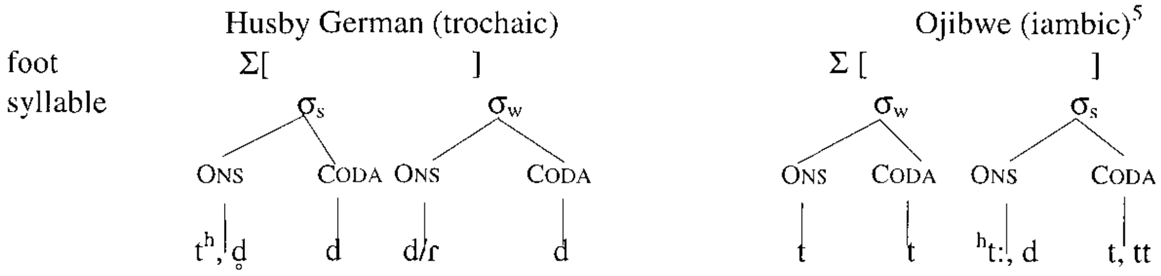
The templatic distributions of laryngeal features in stops for the four languages discussed here are summarized in (5). Darkly shaded cells indicate sites of neutralization, while lightly shaded cells indicate sites where either phonetic reduction or neutralization can occur.

(5) SUMMARY OF POSITIONAL ALTERNATIONS

Language	(foot-)initial syllable onset	(foot-)medial syllable onset	coda
Husby German: trochaic	supports full contrast, full phonetic expression of features	supports contrast [with reduced realizations]	lenis only
Danish: trochaic	supports full contrast, full phonetic expression of features	neutralization or reduction	neutralization or reduction
Walpole Island Ottawa/Eastern Ojibwe: iambic	either neutralization (Bloomfield) or contrast with reduced realizations (Rhodes)	maximal contrast: lenis voiced and/or spirantized, fortis long and aspirated or preaspirated	supports contrast [with reduced realizations]; or neutralization (phrase finally)
Bannack: iambic	lenis only, sometimes with reduced realizations	maximal contrast: fortis long/glottalized, lenis often spirantized	N/A

In the templatic approach outlined above, the potential of syllabic elements to license both phonological contrast and phonetic enhancement can be directly determined by the relative strength of the syllable within the foot. The foot, then, determines the distribution of stop allophones. The templates of Hus.G. and Ojibwe can be graphically represented as in (6):

(6) THE FOOT AS DISTRIBUTIONAL TEMPLATE



The most notable regularity across the distributional templates of both trochaic and iambic feet is the asymmetry in licensing potential between strong and weak onsets. Weak onsets are poor licensers even when word-initial in an iambic language: due to their association to the weak syllable, such onsets are subject to neutralization or reduction of distinctive features, or even to outright loss of the entire segment. On the surface, however, the laryngeally un-

[5] This is the distribution following Bloomfield's description; following Rhodes (1985), the distribution would appear somewhat different, though with foot-initial syllables still constrained in a way that stressed syllables are not.

marked series tend to behave as articulatory phonetics would predict they should: the typical realization of the unmarked series in Ojibwe and Bannack is voiceless lenis word-initially but voiced and potentially spirantized medially. Strong onsets, however, show maximal phonetic elaboration of underlying phonemic contrast: in both Ojibwe and Bannack, we note lengthening and/or strengthening of the laryngeally marked series often contrasting with weakened realization of the laryngeally unmarked stops.

The templatic view allows the distributional effects noted in (5) to be unified as a single type of distributional template, with the site of maximal contrast determined entirely by the foot parameters of each language:

POSITION	SUPPORTED CONTRASTS
strong syllable onset	full range of contrast (with phonetic enhancement)
coda	contextual markedness/neutralization
weak onset	contextual markedness/neutralization

Distributional restrictions appear not only sensitive to prosodic structure, but follow the headedness parameters required by the metrical foot of the language: it is not root- or word-initial or final position that conditions alternations in consonantal strength so much as the location of the head element of a prosodic domain. As noted earlier, this is due to metrical coherence in the grammar: the prosodic structures of the language are central to the organization of the phonology, conditioning distributions and alternations not only at the metrical level but also at the segmental level.

2 Prosodic domains as distributional templates

Though "strong" and "weak" may be intuitively obvious in their descriptive meanings, it is important to clarify exactly what is meant by each, as well as the subset of positions to which these labels can apply. Zoll (1998:8) uses the following criteria to distinguish the phonological properties of strong and weak positions:

	strong	*weak*
contrast	supports more contrast	supports less contrast
reduction	resists reduction	yields to reduction
stress	attracts stress	does not attract stress
tone	attracts H tone	does not attract H tone
harmony	commonly triggers harmony may resist assimilation	may yield to harmony

For current purposes, Zoll's criteria serve as an adequate diagnostic and capture the distributional asymmetries in supported contrast versus reduction as discussed above. Diagnosing elements of the prosodic hierarchy as strong or weak, however, will require an elaboration of the prosodic hierarchy and dominance relations within prosodic domains. I will assume the following set of structures, which are somewhat simplified and reduced from the full range of possible prosodic constituents. These structures and organizing principles follow the model of syllable structure and the prosodic hierarchy proposed by Blevins (1995) unless otherwise noted:

> *prosodic word* (ω): consists of one or more *feet.* Some recent analyses (Zoll 1998) have argued that if the PrWd contains more than one foot, one of the feet will be designated the head prosodic word, and that this constituent can restrict the application of certain phonological processes.
>
> *foot* (Σ): following Hayes' (1995) foot typology, feet are binary at the level of syllables (σ) or moras (μ). Syllabic trochees are headed by their leftmost syllable. Iambs, if they contain more than one syllable, are headed by their rightmost syllable. Iambs may not contain a heavy syllable (>1 mora) in their left branch.
>
> *syllable* (σ): consists of a *rhyme* and an *onset.* The rhyme consists of a vocalic *nucleus* (the head of the rhyme) and an optional *coda* which may contain consonantal material. The onset is an adjunct of the rhyme but its content is not constrained by the melodic content of the rhyme. (Thus, rhymes are headed, but syllables as a unit are not.)

These definitions, including the definitions of the heads of each domain, provide the basis for the definitions of strong and weak positions. *Strong* refers to the head position of a prosodic domain as well as to those constituents that are immediately dominated by it. Such elements are subject only to the general well-formedness constraints applicable to their level of structure (i.e., onsets in a strong position must be well-formed onsets, but will not be subject to any other systematic restrictions). *Weak* positions are those which are both adjacent to a strong position and, though contained within the same domain as the strong/head position, are not themselves heads. Examination of the lenition patterns in (6) above reveals that strong positions need not necessarily be domain-initial and vice versa: languages such as Bannack and Copala Trique (Macken & Salmons 1998) show neutralization and even reduction of stops foot-initially, contrary to the expected phonetic tendency for stops to strengthen in such positions (cf. Fougeron & Keating 1997). This shows that strong positions vary with the position of the head of a prosodic domain, rather than simply following from descriptive criteria.

2.1 Constraint types in the prosodic template

Formally, as noted above, strong positions can be equated with a lack of constraints over supported contrasts and feature realizations. Weak positions, by contrast, will show either neutralization or a restricted range of contrast with phonetically reduced implementation of distinctive feature values. The question of which features are disallowed will be discussed presently, but as preliminary examples, we might state the following sets of constraints for Hus.G.:

(7) WEAK POSITION CONSTRAINTS FOR HUSBY GERMAN (*first formulation*)

*[spread glottis]/CODA	"[spread glottis] is disallowed in codas."
*[spread glottis]/ $\Sigma\{\sigma_s\ \underset{\text{ONS}}{\underset{\vert}{\sigma_w}}\}$	"[spread glottis] is disallowed in the onset of the weak syllable of a foot."

These weak position constraints are an accurate, though disjunctive, statement of the distribution of features in various templatic positions. Our goal must obviously be to provide an explanation of weak position effects that avoids such a disjunction.

Harris' (1997) theory of Licensing Inheritance allows the disjunction in (7) to be circumvented, although not without presenting further problems in terms of representation. Licensing Inheritance starts from the position that all phonological units in a domain except the head of the domain must be licensed (the Phonological Licensing Principle, Harris 1997:336). Licensing of syllabic constituents follows from the licensing potential of the syllable nucleus: onsets are licensed by nuclei, codas by following onsets. Similarly, non-head nuclei are licensed by head nuclei within the same domain. Licensing Inheritance, then, states that the potential of various positions to license melodic material is in an inverse relationship to the number of elements which license a particular constituent. That is, a head nucleus should be unrestricted, a non-head nucleus more restricted, the onset of a non-head syllable still more restricted.

Licensing Inheritance assumes the privative specification of features or melodic elements, and further assumes that these melodic elements are directly phonetically interpretable. Neutralization is the result of the suppression of melodic elements in given positions. In Harris' example, a labial stop consists of three elements: *U*, or labiality (place features); *?*, or stop qualities; and *h*, or noise/release burst. The suppression of one or more of these elements can result in the following types of lenition (343):

suppression of *?* (stop qualities) = spirantization, i.e., [f]
suppression of *U* (place) and *h* (release) = stop debuccalization, i.e., [?]
suppression of *U* and *?* = spirant debuccalization, i.e., [h]
suppression of *?* and *h* = vocalization, i.e., [w]

Such representations and constraint mechanisms give us a clear picture of how and why neutralization occurs in various positions: non-prominent positions are constrained in their capacity to license melodic contrast, and the types of neutralization found in these positions is due directly to the suppression of privative melodic elements. Nonetheless, Licensing Inheritance does not provide a clear explanation for the strong degree of variability in the surface realization of laryngeally unspecified plosives found in the languages described in section 1. Why, if features are directly phonetically interpretable, should a stop with identical feature specifications–such as the lenis series in Ojibwe–show realizations ranging from fully voiceless to voiced spirant, depending its position in the foot? To resolve this question, we would be forced into an overspecification of phonetic detail in phonological analysis, obviating the advantages of a privative feature system, namely, economy in representation.

2.2 Formulation and application of weak position constraints

Weak position constraints, as proposed here, retain the advantages of privative feature specifications as in the theory of Licensing Inheritance, referring only to the marked feature value that defines an opposition. The relevant question in considering neutralization and reduction, however, is that of the nature of the contrast itself, namely, what distinctive information is preserved or lost in various positions? Surface variation in the phonologically unspecified (or underspecified) member of a series is left here to surface phonetic detail rather than phonology. In the absence of a distinctive feature specification, segments show surface variation in their realization according to phonetic context: post-pausal stops are prone to be more voiceless than their intervocalic counterparts (cf. for example Iverson 1983 on the noncontrastive voicing of Korean plain stops intervocalically). Intervocalic stops are more likely to become spirants than initial stops, and so on. Such shifts have no phonological consequences, however, in the sense that they neither create nor eliminate contrast. They are thus not considered at the phonological level. This understanding of contrast and neutralization is similar to that of Natural Phonology, where contrast is viewed relative to a principle of contrast sharpening or "figure and ground" (Dressler 1996:42): in prosodically strong positions, elements tend to be foregrounded or enhanced relative to prosodically weak positions. Similarly, perceptually salient or systemically relevant information will also tend to be enhanced or strengthened at the expense of weaker elements; as with a figure displayed against a background, the relevant information is highlighted or foregrounded relative to its background.

Weak position is, of course, dependent upon a strong position: the labels *weak* and *strong* have no relevance outside of a grouping of phonological units in a metrical domain. This grouping in itself creates an intrinsic ordering of structural demands, essentially an instantiation of the Elsewhere Condition: strong positions are those that are unregulated, the most general case where underlying contrasts are free to occur on the surface. In other positions (i.e., weak positions), a more specific delimitation of allowable features or sets of features will override the more general, unrestricted case found in other positions. There is thus no need to define a constraint set that holds over strong position only: it can be assumed that any constraint holding in strong position must also hold in weak position.[6]

Defining weak position constraints, then, requires reference only to the levels of structure at which marked features are neutralized or banned. I will adopt the following formula for such constraints:

(8) WEAK POSITION CONSTRAINT SCHEMA

> WEAK([feature]/DOMAIN(S)): "a feature is constrained in the non-head sector of a headed prosodic domain." Headed domains include: RHYME, FOOT, PROSODIC WORD.

Constraints over features in syllable codas (the Coda Condition, Itô 1986) are expressible as WEAK([feature]/RHYME), "a feature is disallowed in the non-head sector of the rhyme (i.e., the coda)." The advantage of this formulation, rather than traditional coda licensing, is the ability to describe feature bans at any or all headed levels of prosodic structure. The same logic that makes the coda the weak element of the syllable and subjects it to neutralization then applies to the weak sector of the foot or weak elements of the prosodic word.

The distribution of [spread glottis] in Hus.G. can be expressed as a prohibition of that feature in the weak position of the syllabic rhyme (namely, the coda), as well as in the weak position of the foot. Since the weak position of the foot comprises a syllable, all elements of that syllable will be constrained (the rhyme/coda vacuously, since this element is already constrained). Note that weak position constraints must apply to *headed* prosodic constituents, since it is prosodic heads that provide the definition of weak positions. This means, for example, that onsets will not be constrained unless the entire syllable containing them is constrained (i.e., at the level of the foot or prosodic word).

The constraints of (7) above can thus be recast simply as: WEAK([spread glottis]/RHYME, FOOT), "the feature [spread glottis] is constrained in the non-head sectors of the rhyme and the foot." Thus, the disjunction of codas and foot-medial onsets is described as a set of weak positions at various layers of prosodic structure.

3 Strong, weak and unreferenced positions in templatic analysis

It is important to note that in a prosodic domain, the strong element, which is defined in section 2.1 as unconstrained, is not exempt from structure-changing processes. While the strong element is not subject to neutralization, which eliminates or restricts feature

[6] An exception might be constraints aligning features to root or word-initial position, but these typically reference the initial *edge* of a domain rather than the strong position itself (cf. McCarthy & Prince 1993 for the definition of alignment).

specifications, this does not eliminate the possibility of the allophonic addition of features to strong positions (cf. Holsinger 2000:51–55). In fact, it would be a mistake to view segments or features in strong positions as fundamentally exempt from any change in their phonetic realization. Precisely because strong positions are unconstrained, they tend naturally to become sites of non-structure-preserving processes, allowing phonetic and eventually phonological variation rather than neutralization (again according to the Natural Phonology principle of "figure and ground.") Numerous historical changes in the Germanic languages, for example, have resulted in the shifting of distinctions previously carried by a vowel in a weak syllable to other sites. In addition to the well-known set of sound changes categorized as umlaut, Old Norse u-mutation provides another example from Germanic, cited below in (9a). A templatic consonantal change from Chalcotongo Mixtec, as outlined by Macken & Salmons (1997), where medial consonants were weakened or lost while initial consonants were sometimes strengthened, is summarized in (9b).

(9) TEMPLATIC SHIFTS IN OLD NORSE AND CHALCOTONGO MIXTEC

a. *Old Norse u-mutation* (Noreen 1923): V→ [+rnd]/__ C_0u ("weakly stressed")

Roundness shifts from an unstressed or "weakly stressed" syllable to a preceding stressed or root-initial syllable.

Proto-Germanic	*Old Norse*	*gloss*
(Gothic) *magus*	*mǫgr*	'boy'
*triggur	*tryggr*	'true'
*fehu	*fǿ*	'money, fee'

All forms listed have initial stress.

b. *Chalcotongo Mixtec consonantal shifts* (Macken & Salmons 1997, following Longacre 1957)

The fricative [x] is lost from a foot-medial onset while in some cases, the initial segment of the foot is strengthened.

Proto-Mixtec	*Chalcotongo Mixtec*	*gloss*
*wexi	bèi	'come'
*xexiʔ	zée	'eat'
*kixi	kii	'will come'

Vowel diacritics indicate tone rather than stress, but the cited sources agree that syllabic trochees or "couplets" play a morphological role in Mixtec.

The cases above, both from languages with trochaic feet, show the transfer of the burden of contrast away from medial positions towards the strong syllable of the foot. Both consonantal and vocalic material are shown to drift in this manner, often resulting in innovations to the phonological system (the creation of front rounded vowels in Germanic languages, for example). These examples show, however, that the strong syllable of the template is amenable to the addition of structure, while the weak syllable is constrained in its ability to support contrast and tends to shed marked features or structures.

The examples given in (9) show not only that weak positions are limited in their capacity to support certain contrasts, but also that features tend to drift towards the stressed syllable of the foot to be realized there rather than simply being lost. This, again, must be related to metrical parameters in these languages, and allows us to add a further criterion to Zoll's typology of strong and weak positions: strong position tends to attract marked feature values in sound change. In the templatic view, each weak element is naturally bound to another element marked strong. Features lost from the weak syllable, the constrained element, may still be licensed by the strong element of the prosodic domain over which positional bans hold. This should naturally follow the established metrical parameters of the language: features lost from unstressed syllables should drift leftward within a trochaic template, rightward within an iambic template. The natural pairing of strong and weak elements in a template should mean that marked feature values will seek out a site where they can be licensed in the absence of constraints mitigating against such drift.

It is worth noting that changes such as those described in (9) contradict the predictions made by Positional Faithfulness constraints in Optimality Theory, namely, that strong positions should by nature be resistant to change. The "weak positions" schema outlined above views such change as a natural consequence of the loss of distinctive information from constrained positions. Furthermore, the types of initial consonant weakening described in the data from Ojibwe and Bannack (in 3 and 4, above), represent a fundamental problem for the Positional Faithfulness approach: consonants in root-initial position, especially in unpreceded root-initial position, would not be expected to weaken or fail to support contrasts found elsewhere. Again, the "weak positions" schema can relativize the strength of such positions according to the headedness of prosodic structures in a given language.

3.1 Alignment, augmentation, and positional bans

In Optimality Theory, the family of alignment constraints provide a means of capturing patterns of feature drift such as those in (9). Alignment constraints reference edges of words, roots, or metrical feet in determining the distribution and direction of spread of features; any available edge might potentially serve as a reference point for such constraints. Davis (1999), for example, discusses the distribution of /h/ and aspiration in (American) English and in the Arawakan language, Baré, viewing both as resulting from ALIGN constraints holding over [spread glottis] at different levels. His examples are presented in (10):

(10) THE DISTRIBUTION OF [spread glottis] IN BARÉ AND AMERICAN ENGLISH (following Davis 1999)

a. Baré possessives

haba 'fingernail'	*hnu-aba* 'my fingernail'	*p^hi-aba* 'your fingernail'
nene 'tongue'	*nu-nene* 'my tongue'	*bi-nene* 'your tongue'[7]

but cf. Aikhenvald (1995): *nu-kat^hesá-waka* (1sg-know-NEG) "I don't know" (no drift of [spread glottis] from noninitial aspirated stop), *titehe* "knife" ([h] outside of word-initial position)

b. English aspiration and /h/ resulting from alignment of [spread glottis] to stressed syllable onsets and the left edge of the word, viz. constraints ALIGNL(σ́, [spread glottis]) and ALIGNL(WORD, [spread glottis]).

onsets of monosyllables	[kʰæt]	*cat*;
word-initial syllables	[kʰæ̀təstráfɪk]	*catastrophic*;
primarily stressed syllables	[kʰæ̀tətʰánɪk]	*catatonic*;
certain word-medial syllables	[æ̀brəkʰədǽbrə]	*abracadabra*.

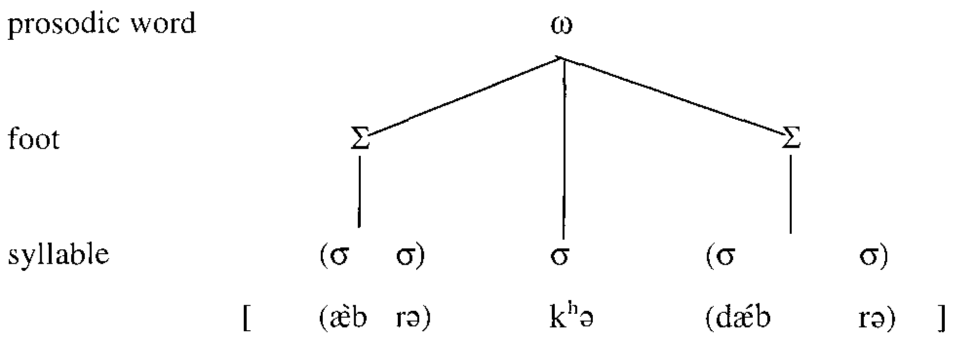
In the data in (10a), Baré shows some cases of [spread glottis] drifting toward initial syllables, but this does not appear to be a categorical behavior of the feature: a number of lexical items in Baré show [h] or aspiration outside of initial position. The behavior of [h] relative to the possessive prefixes seems to indicate a classic autosegmental behavior: in a certain class of lexical items, [h] (or [spread glottis]) is preferentially associated to the initial element of a stem. This is not, however, a property of strong positions, as seen by the appearance of [spread glottis] outside of initial position in other lexical items. Rather, it is a property of certain morphemes that [spread glottis] be aligned to the initial word edge. This, in itself, appears to be a good argument in support of alignment. Though banning this feature from non-head syllables, as a weak position constraint would, captures the distribution of [h] in possessive forms, it does not explain the appearance of aspiration and [h] in the other forms cited. In the absence of morpheme-specific alignment constraints, an Optimality approach should presume that faithfulness will select any underlying specification for /h/ or [spread glottis]. Thus, a weak position constraint alone cannot capture this distribution.

This is not in itself a reason to abandon the notion of weak position constraints, however. The leftward drift of /h/ in Baré possessives appears to be morpheme-specific: Kager (1999:119) argues that relativization of constraints to specific morphemes is limited to the class of alignment constraints. Thus, this behavior can be relativized to a single morpheme, weakening neither alignment theory nor the logic of weak position constraints as determiners of contrast distribution.

[7] Davis presumes a highly ranked constraint *[sg, +voice], since voiced segments never appear aspirated in Baré (preventing, for example, *bʰi-aba 'your fingernail').

We see a theoretical advantage for weak position constraints as opposed to alignment in the distribution of [spread glottis] in English, however. Numerous previous analyses have addressed the question of limitations on aspiration and /h/ (starting in generative phonology with Kahn 1976). Typically, such approaches have attempted to explain where the feature [spread glottis] is found. It seems more appropriate in a constraint-based approach to ask where this feature is *not* found, and this indeed leads to a clearer picture of its distribution. While [spread glottis] seems to align itself at one of two prosodic domains, as expressed by Davis through the constraints ALIGNL(σ́, [spread glottis]), and ALIGNL(WORD, [spread glottis]), [spread glottis] is in effect found everywhere *except* in codas and in syllables following a stressed syllable, i.e., a foot-medial weak onset. As Davis notes, between two stressless syllables, both aspiration and [h] are possible, as in the names *Nèbu*[k^h]*adnézzar*, *Wìnne*[p^h]*esáukee*, or *Tàra*[h]*umára*. Furthermore, in some American English pronunciations of these words, [spread glottis] appears in an onset of a schwa-headed syllable, a combination not attested elsewhere.

I will assume that in these admittedly unusual cases, prosodic structure is constructed such that feet are aligned to word edges. Holding to the assumption that feet are maximally binary, this means that intervening material must be metrically weak and licensed not by adjunction to a foot (creating a ternary structure) but by direct incorporation into the prosodic word. This entails a rejection of the Strict Layer Hypothesis (Selkirk 1982), but constrains the possible foot structures of a language such that ternary feet are not acceptable. By my analysis, the metrical structure of a word such as *abracadabra* is as follows:



Unfooted syllables that are not licensed directly by the Prosodic Word, e.g. the medial syllables in *Nebu*(kad)*nezzar*, *Winne*(pe)*saukee*, and *Tara*(hu)*mara*, escape constraints holding at the foot level. They do not belong to a headed prosodic domain to which a weak position constraint applies, and accordingly cannot be classified as either strong or weak. This leads to a quite simple explanation of the distribution of aspiration and /h/: weak position constraints hold over [spread glottis] apply at the level of the rhyme and the foot, but not at the prosodic word.

Furthermore, if we follow Iverson & Salmons (1995) in assuming that [spread glottis] in clusters is realized throughout the cluster, resulting in an incompletely aspirated second element (e.g., [spɪn]), there is no need to propose an additional constraint over aspiration in clusters.[8] The necessary constraint on [spread glottis] in (American) English bans its appearance in weak syllable onsets, since the only instance where there is no [spread glottis] release, apart from clusters and codas, is in unstressed, footed onsets (e.g., rá[p]id). Thus, the positional ban, WEAK([spread glottis]/RHYME, FOOT), adequately captures the distribution in a way that neither alignment nor positional faithfulness constraints can, eliminating a disjunction of environments in favor of a set of paradigmatic alternations.

Kahn (1976) presents a very similar argument that has long been accepted in discussions of English aspiration. He analyzes American English stops as aspirated in syllable onsets except when the stop in question is ambisyllabic. The weak position approach has one major advantage over Kahn's analysis in its simultaneous capture of the absence of /h/ and aspiration in both codas and post-stress onsets. Again, these environments are joined simply as weak positions at two different structural levels, expressing a relation between a feature and its presence in non-head positions in both rhyme and foot. The dubious theoretical device of ambisyllabicity can then be avoided entirely.

3.2 Unreferenced positions within the template: neither strong nor weak

The data discussed above suggest that a third possibility exists for constraints holding over positions in prosodic domains. Specifically, we see that features banned from weak positions might surface not only in strong positions, but also in positions for which no distributional constraints hold. A given prosodic domain should typically have one position marked strong and one position marked weak, but may contain other positions with no particular status, such as degenerate feet or unfooted syllables within a prosodic word. Such positions are neither strong nor weak, and will not participate in structure-changing processes that affect the other positions. If we assume that [spread glottis] in English is banned from foot-medial positions, for example, the same feature could still potentially surface in unfooted positions within a prosodic word. In other words, a given weak position constraint might hold at the level of rhyme or foot, but not at any higher levels.

Historical lenition processes affecting [d] in Emsland German gives us further evidence of this type of distribution. In this Low German dialect, the unstressed syllable of a syllabic trochee is the site of various processes of reduction and deletion, as listed below. Following a long vowel or diphthong, as in (11a), /d/ appears as a glide homorganic to the preceding vocalic element (also analyzable as deletion of /d/). Following a short vowel, as in (11b), /d/ appears as a coronal flap. Originally geminate segments, shown in (11c), appear as singletons. The orthography of the Middle Low German cognates is ambiguous for Emsland German: a

[8] Some unrelated constraint must still account for the fact that /h/ does not appear in English clusters.

double consonant can indicate either a historical geminate or a preceding short vowel. In most Low German dialects, closed-syllable shortening and degemination have leveled this distinction such that the spelling always indicates a sequence of short vowel plus singleton consonant. Emsland German preserves the historical length distinction in the case of this particular consonant as an alternation between flaps and singleton consonants, though always preceded by a short vowel.

(11) D-WEAKENING IN EMSLAND GERMAN (transcriptions adapted to IPA from Schönhoff 1908: §171, 164)

	IPA	*gloss*	*Middle Low German gloss*
a.	[tɔ́ɒfbòʊ̯ə] [9]	'peat cellar'	*torfbode*
	[moʊ̯ə]	'mother'	*moder*
	[høʏ̯ən]	'to protect'	*hüden*
b.	[bɛɾə]	'bed'	*bedde*
	[mɪɾə]	'middle'	*midde*
	[lʏɾək]	'small'	*lüddek*
	[sχʏɾən]	'to shake'	*schüdden*
c.	[bɪdən]	'to request'	*bidden*
	[fɛdɐ]	'cousin'	*vedder*
	[hœdə]	'(he) protected (pret. ind.)'	*hödde*

The examples given in (11) can all be uncontroversially parsed into single trochaic feet with the exception of *torfbode* (11a), which is a compound composed of two feet. In all of these forms, /d/ is subject to weakening processes under two conditions: (1) it must occur foot medially, and (2) the following vowel must be one of the canonical reduced vowels (i.e., [ə, ɐ]) or a syllabic sonorant.

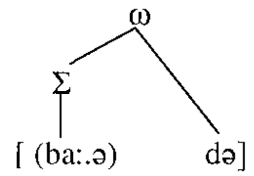
The templatic nature of these weakening processes can be illustrated on the basis of the exceptions to d-weakening cited in (12). After an overlong, falling diphthong (12a), [d] is retained. Here, the trimoraic diphthong (a sequence of long vowel plus schwa) presumably constitutes a foot on its own; the following syllable lies beyond this foot and thus outside the conditions for d-weakening. The quality of the following vowel also affects the process: (12b) shows that weakening fails in the presence of an unreduced vowel. Some scholars of German (Hall 1998, Jessen 1999) have argued that suffixes such as *-los* "-less, lacking" and *-haft* "-ful, containing" (though not *-ig*) inherently possess secondary stress. If Emsland German *-ig* bears secondary stress, we can presume that this suffix, or potentially even the presence of any non-schwa vowel, blocks reduction.

[9] This word is a compound, with the initial syllable (the root *torf*, "peat") receiving primary stress.

(12) EXCEPTIONS TO THE WEAKENING PROCESSES IN EMSLAND GERMAN

	IPA	*gloss*	*Middle Low German cognate*
a.	[ba:ədə]	'both'	*beide*
	[ha:ədə]	'heath'	*heide*

metrical structure:



prosodic word

foot

b.	[nø:dɪχ]	'necessary'	*nodig*
	[ni:dɪχ]	'spiteful'	*nidig*
	[kry:dɪχ]	'lively'	*krüdig*

These two cases provide strong evidence of the necessity of contextual markedness constraints that ban features from a set of prosodically-determined weak positions. Both alignment constraints and positional faithfulness fail to explain the occurrence of features otherwise limited to strong or edge positions outside of their prescribed domains. Why, for example, would [spread glottis] be found in certain metrically non-prominent positions as opposed to others? While alignment constraints could certainly be invented to capture this distribution, the alignment argument weakens in view of a single markedness constraint that results in the same pattern. Positional faithfulness fails here for the same reason: why would nonprominent, unfooted syllables allow exceptional feature identity constraints of a type justified on the basis of the phonetic and psycholinguistic strength of stressed and initial positions?

Weak position constraints neatly capture both the static distribution of [spread glottis] in English and the historical weakenings of [d] in Emsland German as natural consequences of the limitations placed on feature distribution within the foot. The fact that these constraints apply at the foot level does not, however, mean that constraints could not apply within the prosodic word. A constraint WEAK([spread glottis]/RHYME, FOOT, PRWD), for example, would eliminate the feature [spread glottis] from any coda, as well as from any unstressed onset within the entire prosodic word, rather than simply from foot-medial onsets, as in English. Whether or not a constraint of this type is attested will remain an open question at this point.

4 Weak positions

We turn now to an examination of another type of weak position constraint. As argued above, phonologically weak does not necessarily equate to phonetically weak. Rather, the primary characteristic of a weak position is that it is constrained. Phenomena like German final fortition show that weak position constraints can also result in the neutralization of contrast through the obligatory insertion of a feature. Though this type of neutralization (i.e., to the marked element of a distinctive alternation) is not widely accepted in phonological analyses, there are cases that appear to require it, as will be discussed below.

4.1 "Neutralization to the marked"

The process commonly called "final devoicing" in German was referred to by pre-SPE Germanists (e.g., Schirmunski 1962) as "final fortition" (a perspective which Iverson & Salmons 1995, 1999 have grounded in current feature theory). This reflects the general view that the German "voiced" or lenis obstruents were phonetically strengthened in the syllable coda. As Iverson & Salmons (1999) argue:

> Since "voiced" or lenis obstruents are not laryngeally marked in this system, there is no laryngeal feature available to spread leftward into a fortis (or fortified) segment. Obviously, the feature which is available in the system, [spread glottis], cannot spread leftward into an already fortis obstruent. By Final Fortition, therefore, both /s+b/, /z+b/ → [sb] (*Eisbär* 'polar bear', *eßbar* 'edible'), while /z+p/, /s+p/ → [sp] (*Hausputz* 'big housecleaning', *Fußpilz* 'athlete's foot'). In German, then, all members of a heterosyllabic cluster come to share the laryngeal specification of the last member if there is such a specification (namely, [spread glottis]), but this is an effect of Final Fortition, not a consequence of feature spread or assimilation. Further, if there is no laryngeal specification in the last member of the cluster, the preceding member will still be fortis because of Final Fortition, resulting in laryngeally heterogeneous clusters like [sb] (= [sb̥]).

In other words, in a system where obstruents are distinguished by the presence or absence of [spread glottis], this feature is obligatory any time an obstruent is associated to a right syllable edge. The marked feature can spread into following unspecified obstruents as well.

Up to this point, neutralization has been described as a situation where contrastive specifications for feature X are disallowed in the weak sector of domain Y. Neutralization could conceivably also occur via a requirement that a specific feature value always be present in weak domains (i.e., all weak sectors of domain Y must contain feature X). Both types of requirement eliminate contrast, but the mechanism by which contrast is eliminated is presumably a matter of language-specific implementation. Weak position constraints specify only the phonological consequences of neutralization, leaving the phonetic dimension of feature implementation open.

One advantage to this view of neutralization is that it allows us to circumvent other formal devices, such Harris' (1997) analysis of the behavior of final consonants under Licensing Inheritance. Specifically, he argues (1997:354-356) that final consonants are syllabified as onsets with a following empty nucleus (a generally accepted position in Government Phonology). The presence or absence of a vowel in the nucleus of a following syllable determines whether (L), the phonological element that determines voicing, can appear. Standard German final devoicing in *Han*[t] "hand (sg.)" vs *Hän*[d]*e* "hand (pl)." is explained in this manner.

This analysis crucially relies on the characterization of some German stops as voiced. Though Harris classifies the Danish voicing alternation as aspirated vs. plain and characterized phonologically by the element (H), or plosive aspiration, German, whose phonetics and phonology match the criteria used to determine the Danish distribution (cf. Jessen 1998), is not characterized in the same way. If we accept the good arguments that exist for assigning the same phonological feature to both the German and Danish stops, this leaves a Licensing Inheritance analysis in a bind. Since plosive aspiration does not appear in weak onsets, we would assume that (as in Danish), (H) is not licensed there. But with the assumption that final consonants are onsets, and more specifically that they are onsets with no (H) license, there is no way to motivate neutralization of final consonants to the marked series except to recognize that this is a property categorically associated to coda consonants.

All other things being equal, the consistency of analysis for the laryngeal features of the two languages is certainly preferable, as is the assumption that final consonants are codas when they behave like all other codas. Where Danish and German are distinct, then, is in the types of constraints that hold over codas: Danish has moved in the direction of feature elimination, while German requires neutralization to a marked feature value.

4.2 The onset position in distributional templates

The systematic distinction between the behaviors of weak onsets and codas discussed above leads us now to a discussion of the asymmetries that exist between strong and weak onsets. Work on phonological acquisition (Fikkert 1995, Gerken 1996, Macken 1996; cf. also Kehoe & Stoel-Gammon 1997) shows that children, in the development of their phonological systems, frequently restrict certain features to prosodically strong positions, such as the initial syllable of a trochaic foot, and that during acquisition, children acquire first syllabic templates, then feet, and finally, fully-formed prosodic and intonational structures. The stage at which the foot becomes functional for children is characterized by clippings of polysyllabic words to fit the template, or more rarely, by epenthesis such that monosyllabic forms become disyllabic. The presence of such an acquisitional stage suggests that a close relationship between features or segments and units of prosody might be a fundamental aspect of phonological systems; whether the prosodic template continues to play a role in adult phonology or is simply lost after more fully-elaborated prosodic structures are acquired remains a point of discussion.

Macken (1996) notes strong restrictions in some children's speech as to the ordering of consonants with certain places and manners of articulations, as well as directional effects of consonantal harmony processes by which medial onset consonants assimilate place of articulation to a preceding onset, but not a preceding coda consonant. As she states: "A crucial factor is not linear order of the segments *per se* but rather prosodic structure, specifically the prosodic template and the onset positions in that template, and that, within the prosodic structure, there is a directionality effect" (1996:169). Distributional templates obey principles of headedness in the same direction as the stress templates of a given language: in a language with iambic feet, the initial onset is weaker and subject to neutralization, despite its position at the beginning of the word, a position which is commonly argued to be more perceptually salient.

Furthermore, the asymmetric behavior of onsets comes as a natural consequence of prosodic headedness in the templatic approach. Within the syllable, onsets are undominated. While they are not the head of the syllable, neither are they constrained by the melodic content of the nucleus, and thus are unconstrained. A constraint over an entire syllable, though, would constrain a syllabic onset. Given the weak position constraint schema proposed in section 2.2, the demarcation of one syllable in a foot as weak applies to all dependent element of that syllable, including the onset. In fact, it is *only* at the level of the foot that constraints over syllables (and thus onsets) become possible, since feet have syllables as heads (and thus also as non-head elements). When a weak element can be constrained only in reference to a strong element within a headed domain, there is no way of constraining onsets except via the syllable (thus at the level of the foot). Any independent definition of an onset grants undue power to the theory, and would predict constraints on onsets relative to nuclei that are not found in human language.

Many prosodically-triggered sound changes, such as those mentioned above, involve reduction of contrast in certain positions and the concomitant shift of distinctive features to the head position of a prosodic domain. Let us examine the Old Norse sound changes already noted in (8) above as an example, listed here again for expository convenience:

Proto-Germanic		*Old Norse*		*gloss*
(Gothic) *magus*	[maː.gʊs]	*møgr*	[møgr̩]	'boy'
*triggur	[trɪg.gʊr]	*tryggr*	[tryg.gr̩]	'true'
*fehu	[fɛ.hu]	*fǿ?*	[føː]	'money, fee'

Transcriptions are reconstructions of likely pronunciations.

A weak position constraint, WEAK([round]/FOOT), expresses the loss of distinctive [round] from the weak sector of the foot. The constraint is presumably not WEAK([round]/RHYME) since it does not eliminate rounded vowels entirely. Rounded offglides of diphthongs are still attested, as in *auka* "to increase". Whether the constraint is better formulated as WEAK ([round]/PRWD) is not apparent from available data. Though the feature [round] is no longer preserved in the same position where it was specified in the input, it is nonetheless preserved by the nearest available unconstrained licenser within the same domain. In the absence of a higher-ranked well-formedness constraint against front rounded vowels, the feature [round] can be added to the vocalic specifications of the initial syllable, producing front rounded vowels and creating a new contrast. (The eventual deletion of the unstressed vowel and resulting monosyllabic forms are not considered here.)

While strong positions may be subject to universal feature co-occurrence or well-formedness constraints, such constraints are necessarily apositional and reflect the broader demands of the phonological system: they will apply to any disallowed combination of features, regardless of the prosodic constituency of their potential licensers and do not reflect on any theory of distributional asymmetries. The role of weak position constraints appears crucial to the motivation of diachronic shifts such as the Old Norse example above. Since weak position constraints are expressed over features and structural levels, if phonological systems tend to preserve distinctive information (the nature of faithfulness in Optimality Theory), the restriction of a distinctive feature in a weak position need not eliminate contrast entirely if the strong element can "pick up" the feature in question.

5 Summary and conclusion

In sum, I hope to have shown a number of advantages of a templatic approach to contrast distribution. My analysis has expressed the utility of a type of constraint that determines the ability of headed prosodic constituents to support contrast. The advantages of these constraints are threefold. First, the weak position constraint schema is dependent on pre-existing parametric variation in prosodic structures, which gives a clear phonological explanation to the initial consonant weakenings found in some iambic languages. A "phonetics-only" approach would not predict the loss or spirantization of word-initial stops, for example, simply because the phonetic context is not appropriate for such processes. Second, the weak position approach captures static distributions clearly, without need for exceptional syllabifications or other formal devices. Rather, it attempts to derive the phonological contexts of neutralization from the natural asymmetries inherent in metrical groupings at all levels of metrical structure, further deriving the asymmetries of strong and weak onsets within the foot from well-established principles of syllabic structure. Finally, the templatic approach provides a clear explanation for prosodically-motivated sound change, arguing that contrast preservation naturally occurs within the same domain in which features become constrained, migrating from weak to strong positions.

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This Word is a Phrase, Phonologically: Evidence from Persian Stress*

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The superficial diversity of stress patterns in Persian has led linguists to suggest a split between Persian lexical categories in this respect. Some examples of Persian words and their main stress are given in (1).[1]

(1)	a. ketâ´b	"book"	e. xaríd	"s/he bought"
	b. mosâbeqé	"competition"	f. xaríd-am	"I bought"
	c. ketâb-í	"bookish"	g. mí-xar-e	"s/he buys"
	d. divuné	"crazy"	h. ráft-am	"I went"

The examples in (1a-d) show that for nouns and adjectives the main stress goes on the final syllable of the word. As for the verbs in (1e-h), however, the pattern is not as clear. Whereas in (1e), the main stress is on the final syllable, (1f, h) exhibit main stress on the penultimate syllable and (1g) on the initial (or antepenultimate) syllable. As a result of such superficial differences, scholars have proposed different stress rules for nouns and adjectives on the one hand and verbs on the other.

Chodzko (1852) was the first to discuss stress in Persian. He identifies as the basic rule that stress is word final in simple, derived, and compound nouns and adjectives, and nominal verbs. As to verbal stress, he has different rules for different tenses. Ferguson (1957), too, distinguishes verbal stress from the other categories. "It is certainly safe to say that in modern Persian the verb has recessive stress. This is in sharp contrast with the noun, where the stress tends to be near the end of the word" (Ferguson 1957: 26-7). Similarly, Lazard (1992) makes a distinction between non-verbal words and verbs, with the former having the stress on the last syllable and the latter having "recessive stress". Mahootian (1997) points out that stress is word-final in simple nouns, derived nouns, compound nouns, simple adjectives, derived adjectives, infinitives, and the comparative and superlative forms of adjectives as well as in nouns with plural suffixes, and mentions verbal stress as one of the exceptions to this rule. Finally, in her account of Persian stress under a metrical framework, Amini (1997) proposes

* I would like to thank T. A. Hall, Marzena Rochon and the participants of the "Word in Phonology" workshop in Marburg, Germany for their insightful questions and helpful remarks. Thanks also to Elan Dresher and the students at the University of Toronto for their invaluable comments. I am especially grateful to Keren Rice for her discussions and suggestions since the earliest draft of this paper. All shortcomings and errors are mine. This work has been partially funded by SSHRC Canada # 410-99-1309.

[1] Throughout this paper, the symbol "a" stands for the low front vowel (e.g. Persian *sag* "dog") and "â" stands for the extra-long low back vowel (e.g. *ketâb* "book").

two different word-layer construction rules, i.e. End Rule Left and End Rule Right, which are sensitive to lexical categories. She uses the first rule for prefixed verbs and the second one for all other categories. These attempts show that even a split between verbs and other lexical categories cannot account for the discrepancies observed in the stress pattern of Persian verbs.

The purpose of this paper is to provide a unified (i.e. independent of lexical categories) account of Persian stress. I show that by differentiating word- and phrase-level stress rules, one can account for the superficial differences exemplified in (1) above and many of the stipulations suggested by previous scholars. The paper is organized as follows. In section 1, I look at nouns and adjectives and propose a rule that would account for their stress pattern. In section 2, I extend the stress rule to verbs and show the problem this category poses to our generalization. The main proposal of this paper is discussed in section 3. I introduce the phrasal stress rule in Persian and show that by differentiating word-level and phrase-level stress rules, one can come to a unified account of Persian stress. Section 4 deals with some problematic cases for the proposed generalization and discusses some tentative solutions and their theoretical consequences. Section 5 concludes the paper.

1 Nouns and Adjectives

Some examples of simple nouns and adjectives are given in (2). The stress is word-final.

(2)	a. mú	"hair"	e. xúb	"good"
	b. ketâ´b	"book"	f. bozórg	"big"
	c. tasâdóf	"accident"	g. divuné	"crazy"
	d. buqalamún	"turkey"	h. motefâvét	"different"

The examples in (3) show the pattern of stress when derivational affixes are added to nouns and adjectives. The symbol ω is used throughout the paper to mark a phonological word (abbreviated as PWord in examples and diagrams). Derived nouns and adjectives have their stress on the last syllable, as in (3a-c). (3d) shows that the nominal plural and the comparative markers behave like derivational suffixes and take stress. The superlative marker, not shown here, also takes stress. Note that, based on other morphological evidence, Kahnemuyipour (2000a) shows that adjectival degree and nominal number are derivational in Persian. Thus, one can maintain the generalization that Persian derivational suffixes take stress.

(3)	a. (ketâb-í)$_\omega$	"bookish"	(tasâdof-í)$_\omega$	"accidental"
	b. (bozorg-í)$_\omega$	"grandeur"	(divune-gí)$_\omega$	"craziness"
	c. (nâ-doróst)$_\omega$	"incorrect"	(bi-arzésh)$_\omega$	"worthless"
	d. (ketâb-â´)$_\omega$	"books"	(bozorg-tár)$_\omega$	"bigger"

In contrast, the indefinite article *–i*, the relative particle *–i*, the direct object marker *–o* (formally *râ*), the *Ezafe* vowel *–e* (an unstressed vowel *–e* that links nouns to their modifiers and possessors)[2] and the pronominal enclitics do not take stress. These suffixes are inflectional in nature, having syntactic consequences. The stress pattern induced by these suffixes is shown in (4).[3]

(4)	a. (ketâ´b)$_\omega$-i	"a book"
	b. (ketâ´b)$_\omega$-am	"my book"

The fact that suffixes can behave differently with respect to stress has been attested in many languages. For example, many languages (e.g. Hungarian) parse a sequence of stem plus suffix as a single phonological word, as in (5a), whereas other languages do not parse (some) suffixes with the phonological word of the stem to which they attach, as in (5b). In English, for example, a distinction is made between stress-neutral suffixes (e.g. -ness) and stress-shifting suffixes (e.g. *-ity*). It has been suggested that whereas the former attach at the word level, the latter attach at the stem level.

(5) a. (stem+suffix)$_\omega$ b. (stem)$_\omega$+suffix

Following Dixon (1977a, b) and subsequent writers, I refer to suffixes that are part of the phonological word (i.e. are of the (5a) type) as 'cohering' and those that are not (i.e. are of the (5b) type) as non-cohering. In other words, all derivational suffixes in Persian are cohering, whereas the inflectional ones and clitics are non-cohering.[4] Note the plausibility of the assumption that the suffixes involved in derivation (i.e. a lexical process) attach to the stem and are part of the phonological word. On the other hand, clitics and inflectional affixes are

[2] For two different accounts of the Persian Ezafe construction, see Ghomeshi (1996) and Kahnemuyipour (2000b, forthcoming).
[3] The editors of the volume point out that the representations in (4) raise an interesting question concerning the relationship between phonological word boundaries and syllable boundaries. While an answer to this question is beyond the scope of this paper, one can imagine several possibilities. For example, it might be argued that the syllabification is VC.V or that the consonant is ambisyllabic. Alternatively, a mismatch in boundaries might be allowed. I leave the question for future research.
[4] Note that, as mentioned above, in a paper presented at the LSA conference (Kahnemuyipour (2000a)), I have argued based on morphological evidence that adjectival degree and nominal number are derivational in Persian. Thus, the suffixes in (3d) are considered derivational.

often considered to have syntactic status and are outside the phonological word. It should also be noted that all cohering suffixes in Persian are linearly ordered before the non-cohering ones, a fact which supports the lexical status of the former.

Finally, compound nouns and adjectives are treated as single words and have their stress on the final syllable, as shown in (6). Note that no affix (inflectional or derivational) can interrupt the two parts of these compounds, i.e. they are treated as single words in this respect too.

(6)	a. (ketâb-xuné)$_\omega$	*book-house*	"library"
	b. (gol-forúsh)$_\omega$	*flower-seller*	"florist"
	c. (bozorg-manésh)$_\omega$	*great-attitude*	"magnanimous"
	d. (bad-báxt)$_\omega$	*bad-fortune*	"unfortunate"

So far, we have seen that the word-final stress rule (given below) together with a distinction between cohering and non-cohering affixes can account for the stress pattern in nouns and adjectives.

Word stress rule: The final syllable in the (phonological) word takes stress (End Rule Right).

Next, I will extend the word-final stress rule to verbs.

2 Verbs

In this section and the next, I attempt to account for the stress pattern of verbs in Persian. Recall from the introductory examples in (1) that verbs exhibit a pattern which is different from nouns and adjectives, one that can hardly be captured even with category-dependent rules (see, for example, Amini 1997). I show that this apparent difference can be accounted for if a distinction is made between word-level and phrase-level stress rules in Persian.

Let us start with the simplest form of Persian verbs, i.e. those with no verbal affixes (third person preterites). These verbs follow the word-final stress rule proposed for nouns and adjectives. This is shown in (7).

(7)	a. (ráft)$_\omega$	"s/he went"
	b. (xaríd)$_\omega$	"s/he bought"
	c. (tarâshíd)$_\omega$	"s/he sharpened"

Person agreement suffixes are non-cohering in Persian. Thus, as shown in (8), they do not attract stress. Recall from the previous section that inflectional affixes (as well as clitics) are generally non-cohering in Persian. Therefore, the behavior of person agreement suffixes is not at all surprising.

(8) a. $(\text{ráft})_{\omega}$-am "I went"
b. $(\text{xaríd})_{\omega}$-i "you bought"
c. $(\text{tarâshí d})_{\omega}$-im "we sharpened"

Note that the stress pattern of the verbs discussed so far is consistent with the word stress rule proposed in the previous section. However, the examples in (9) show that the prefixes marking mood, namely the indicative marker *mi-* and the subjunctive marker *be-*, as well as the negative marker *na-/ne-*, attract main stress. This seems to pose a problem for the word-final stress rule. This very fact has led scholars to posit that Persian stress depends on lexical category.

(9) a. mí-xar-e "s/he buys"
*mi-xár-e
indic.-buy-3sg
b. bé-xar-am "that I buy"
*be-xár-am
sub.-buy-1sg
c. ná-xarid-∅ "s/he didn't buy"
*na-xárid-∅
neg.-bought-3sg

In the next section, I attempt to come to a unified account of Persian stress by making a distinction between word-level and phrase-level stress.

3 Proposal

In the previous section, we saw that the verbal prefixes pose a problem for our word-final stress rule. I suggest that making a distinction between word-level and phrase-level stress rules resolves the problem. Let us look at phrasal level stress in Persian. (10a) shows an example of a verb phrase (OV) and (10b) shows an example of a noun phrase (dem N).[5] Note that I have only marked the phrase-level stress for ease of illustration. Otherwise, each phonological word receives stress at the word level, according to the word stress rule in

[5] Phonological phrase is abbreviated as PPhrase in all the examples throughout the paper.

section 1.[6]

(10) a. PPhrase

s w

(alí)$_{\omega}$-o (did)$_{\omega}$-am PWord

Ali–acc. saw- 1sg

"I saw Ali"

b. PPhrase

s w

(ín)$_{\omega}$ (ketâb)$_{\omega}$ PWord

this book

Here is how the stresses are assigned in the examples in (10). In (10a), each word takes its stress according to the word stress rule. Recall that the suffixes *–o* and *–am* are non-cohering. Thus, at the word-level, the second syllable in *ali* and the first syllable in *did-am* take stress. At the phrasal level, however, the stress falls on the leftmost phonological word (PWord). As a result, the main stress of the whole phrase falls on the second syllable of *ali*. The stress in example (10b) can be accounted for in the same manner. If more elements are added, the stress continues to go on the leftmost phonological word. This is shown in (11). Recall that only phrase-level stress is marked.

(11) a. PPhrase

s w w

(hasán)$_{\omega}$-o (sedâ)$_{\omega}$ (kard)$_{\omega}$ PWord

Hassan-acc. sound did

"s/he called Hassan"

[6] This raises the question as to whether the other (word-level) stresses are audible as secondary stresses. The

b. PPhrase

s w w

(ín)$_{\omega}$ (do)$_{\omega}$ (ketâb)$_{\omega}$ PWord

this two book

"these two books"

All the examples in (10) and (11) can be accounted for with the word-stress rule previously mentioned and the Phrasal stress rule given below.

Phrasal stress rule: The first phonological word (PWord) in the phonological phrase (PPhrase) takes stress (End Rule Left).

Now, let us return to the problematic verbal prefixes in (9). I propose the following as a solution to the problem: The verbal 'prefixes' enter the combination as phonological words, and the phrase-level stress rule puts the stress on the initial word in the phrase, here the prefixes (see (12) below). Recall that at the word level, the stress falls on the last syllable. Thus, the one-syllable prefixes as well as the stems are stressed.[7]

(12) PPhrase

s w s w s w

(mí-)$_{\omega}$ (xar)$_{\omega}$-e (bé-)$_{\omega}$(xar)$_{\omega}$-am (ná-)$_{\omega}$(xarid)$_{\omega}$ PWord

Similar to (11) above, if more preverbal elements are added, the stress continues to go on the leftmost phonological word.[8]

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status of secondary stress is quite unclear in Persian and is not dealt with in this paper.

[7] Note that according to native speakers' intuition and the orthography, the prefixes and the stem are part of the same word. With respect to the orthography, words are written separately in Persian. Note, however, that the negative marker *ne-/na-* and the subjunctive prefix *be-* attach to the verb. The indicative marker *mi-*, which used to be attached to the verb, is written separately by the younger generation. Meanwhile, in most word processors, whereas there is regular space between words, there is almost no space between this prefix and the verb. This distinction can hardly be made for handwriting.

[8] For the status of secondary stress in Persian, see note 6.

(13) PPhrase

s w w w

(dârám)$_\omega$ (ketâb)$_\omega$ (mi-)$_\omega$(xun)$_\omega$-am PWord

prog. book indic. read 1sg

"I am book-reading"

Note that compound verbs follow the same generalization, i.e. they enter the combination as phonological words and take phrasal stress. The non-verbal elements used in the compounds are sometimes simple words (like 11 above) and sometimes adverbial elements not used in isolation, as in (14) below.

(14) a. (forú)$_\omega$ (kard)$_\omega$ "s/he thrusted"

downward-did

b. (pás)$_\omega$ (dâd)$_\omega$ -am "I gave back"

back-gave-1sg

Recall that in the case of nouns and adjectives, compounds were treated as one phonological word (6 above). The same was true for adjectives with derivational prefixes attached to them (3c above). The compound verbs in (14) seem to behave differently. Note, however, that in the case of nouns and adjectives, the two parts cannot be interrupted with other elements (inflectional material, etc.), whereas in the case of verbs, this is possible. This is shown in (15), where the material intervening is given in bold. This suggests that the former is a lexical process and the latter a syntactic one.

(15) a. pas-**esh** dâd-am "I gave it back"

back-it gave-1sg

b. pas **na**-dâd-am "I didn't give back"

back neg-gave-1sg

c. pas **xâham** dâd "I shall give back"

back fut. gave

To summarize, it has been argued in this section that verbal 'prefixes' are phonological words and that all lexical categories in Persian follow the same word-level and phrase-level stress rules. Note that the verbal prefixes are inflectional (syntactic) elements, so perhaps it is not surprising that they function as separate words, given the patterning of the suffixes. The word-level and phrase-level stress rules along with the distinction between cohering and non-cohering suffixes have been able to account for the stress pattern of all Persian words discussed so far. In the following section, we will look at some cases that appear to pose problems to the proposed generalization.

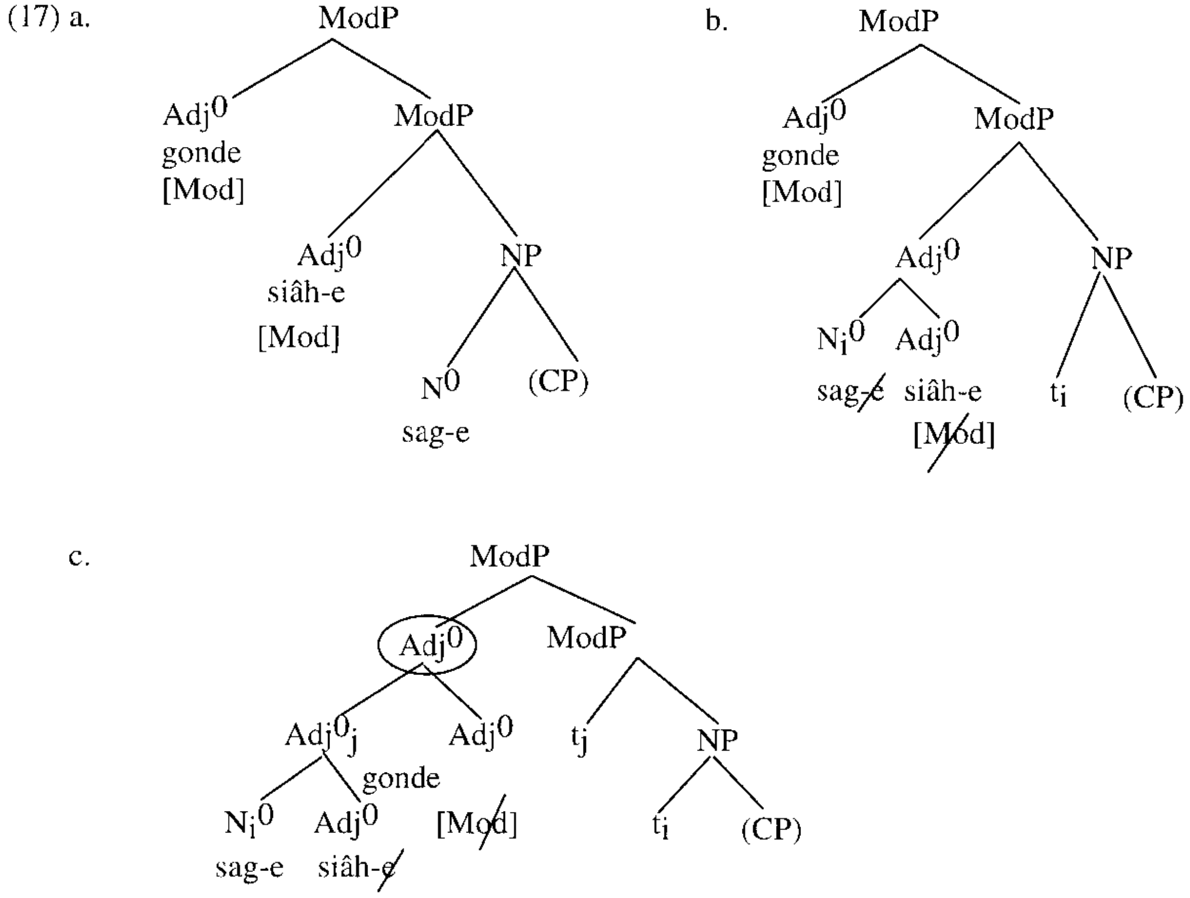
4 Problematic cases

4.1 The Ezafe Construction

There is an apparent exception to the leftmost phrasal stress rule which occurs with respect to a well-known nominal construction in Persian, namely the Ezafe construction. Ezafe is indicated by an unstressed vowel *–e* which occurs on every noun (or adjective) that is followed by a(nother) modifier or possessor. An example is given in (16), which shows that the stress falls on the rightmost word. This seems to be a counterexample to the phrasal-stress rule which would predict main stress on the first word.

(16) sag-e siâh-e gondé
dog-Ez black-Ez big
"big black dog"

Before considering some tentative solutions to this problem, we need to have a closer look at the syntax of this construction. Kahnemuyipour (2000b, forthcoming) examines the syntactic structure associated with the Ezafe construction and argues that the merge position for the modifiers and possessors in the Ezafe construction is prenominal and that their final position is the result of syntactic movement. According to this analysis, the adjectives are located in the heads of functional projections above NP. These adjectives (or modifiers) bear the feature [Mod] (for modifier), and the functional projections are thus called Mod(difier) P(hrase)s. The noun, which also has the feature [Mod] (morphologically realized by the unstressed vowel -e, i.e. the Ezafe vowel), moves up, head-adjoins to the adjective and checking takes place. If there are more adjectives, and thus more functional projections, this process of head-adjunction and checking continues until all strong [Mod] features are checked. The derivation for the example in (16) is given in (17). (17a) shows the merge position. (17b) illustrates the movement and adjunction of the noun to the adjective above it. (17c) shows the movement and adjunction of the whole Noun-Adjective structure to the adjective above it. For ease of illustration, I have only shown the [Mod] feature on the adjectives. Note, however, that the Ezafe morphemes, too, bear a [Mod] feature. Thus, the checking which is shown to take place between the [Mod] feature and the Ezafe vowel, really involves the [Mod] feature on the Ezafe.[9]



It can be seen in (17c) that the final structure of this phrase (circled in the tree diagram) is an X^0-level element, i.e. a word. Consequently, the observed stress pattern could be attributed to the word-level stress rule which puts the main stress on the final syllable of the word, here the whole Ezafe construction.

The syntactic analysis discussed above makes another account of the stress pattern possible. One could argue that the main stress might have actually been assigned at a point in the derivation when the final adjective (the word that surfaces as last in the phrase) was in fact in the leftmost position. This of course implies that stress assignment is not a rule that is applied in the path from spell-out to PF, but rather one that applies to intermediate derivations. Alternatively, one could maintain the conventional view that stress is a PF rule, but that rather than referring to the surface representation, it refers to an abstract stage in the derivation via some notion of trace. This proposal is reminiscent of Bresnan (1971), who argued that the Nuclear Stress Rule, which is responsible for English sentence stress, applies on each cycle after all syntactic rules have applied, thereby permitting the stress relations established in underlying structure to survive throughout the derivation. One of the

[9] For reasons of space, the motivation behind the analysis, as well as some interesting consequences, have been left out. For more details, refer to Kahnemuyipour (2000b, forthcoming).

consequences of her proposal is that the syntactic and phonological components are not discrete and some rules of prosody are included in the syntactic component. Note that recent developments in syntactic theory, namely the notion of 'derivation by phase' and multiple spell-out, seem to have paved the ground for the revival of such proposals. I leave the details of this and other possible solutions to the problem discussed in this section to future research.

4.1 The Negative Marker *ne-/na-*

There is one exception to the generalization that in the verb phrase, the stress always falls on the left-most element. In the case of the negative verb phrase, the stress remains on the negative marker *na-/ne-*, even if other words precede it. This can be seen in (18).

(18) a. ná-xarid-am "I didn't buy"

b. ketâb ná-xarid-am "I didn't buy books"

c. ketâb né-mi-xar-am "I don't (won't) buy books"

In (18b), for example, the main stress falls on the negative marker rather than the leftmost element *ketâb* "book". Note that omitting the negative marker would give the affirmative form "I bought books", in which case the stress would go on the first element *ketâb* "book", as expected. Following are some tentative solutions to this problem.

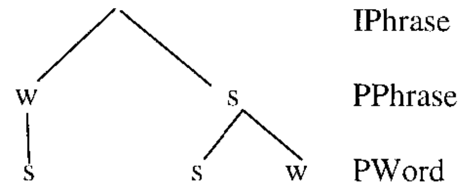
One way to deal with this problem is to suggest that the negative marker is lexically stressed and receives main stress in all contexts. This solution, however plausible at first glance, runs into a problem if we attempt to capture the fact that the negative marker in the negative form of the Persian long infinitives (what Chodzko referred to as nominal verbs) is not stressed. In these forms, the stress falls on the last syllable of the word, as predicted by the word-level stress rule; thus, for example, *na-budán* "not to be", *na-didán* "not to see", etc. In other words, the negative marker is not always stressed in Persian. Note that long infinitives in Persian behave just like nouns, suggesting that they are formed in the lexicon.[10]

A more plausible solution is to propose that the negative marker is a boundary for the phonological phrase and a higher phrase-level stress rule puts the stress on the negative marker.[11] Let us look at the stress rule for a higher phrasal level (i.e. intonational phrase, abbreviated as IPhrase in examples and diagrams). For this purpose, I look at a simple sentence consisting of a subject, an object, and a verb. This is shown in (19). Once again, for ease of illustration, I have only marked the main stress of the whole phrase.

[10] The fact that the negative marker is treated as a phonological word when attached to a finite verb but not to an infinitive has to do with a fundamental difference between the structure of finite verbs and long infinitives, or more generally between verb phrases and noun phrases in Persian. See section 5 for a preliminary attempt to illustrate the distinction.

[11] This solution was brought to my attention by Elan Dresher.

(19)



((hassan)$_{\omega}$)$_{\varphi}$((alí)$_{\omega}$-o (did)$_{\omega}$)$_{\varphi}$

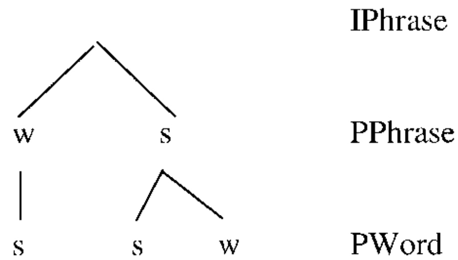
Hassan Ali-acc. saw

"Hassan saw Ali"

(19) shows that at a higher level, the intonational phrase, the stress remains on the verb phrase. In other words, at the level of the intonational phrase, the stress rule is "End Rule Right", which puts the stress on the rightmost phrase, in this example the verb phrase "saw Ali". Recall that within the phonological phrase, the leftmost word takes the main stress and within the phonological word, the last syllable attracts stress. As a result the final syllable in *ali* takes the main stress of the sentence.

Now, let us return to the problematic case, i.e. the negative marker. Assuming that the negative marker is a phrase boundary, the stress assignment can be accounted for in the same manner. This is illustrated in (20), where φ is used to mark phrase boundaries.

(20)



((ketâb)$_{\omega}$)$_{\varphi}$ ((ná)$_{\omega}$-(xarid)$_{\omega}$ -am)$_{\varphi}$

book neg. bought 1sg.

"I didn't buy books"

The stress assignment in (20) above can be explained as follows. At the intonational phrase level, the stress falls on the rightmost phonological phrase, i.e. *na-xarid-am* neg.-bought-1sg. This phonological phrase, in turn, consists of two phonological words, *na* and *xaridam*. According to the phonological phrase stress rule, the stress falls on the leftmost word, i.e. the negative marker. Note that the negative marker is monosyllabic and is thus stressed based on the word-level stress rule. As a result, the main stress of the whole phrase falls on the negative marker.

Let us see if there is a deeper explanation as to why the negative marker constitutes a phrase boundary. Kahnemuyipour (2000c) argues for a preverbal focus position in Persian which is the locus of contrastively focused elements as well as wh-phrases. The fact that focused elements are often at the edge of a phrase has been proposed in the literature (e.g. Kanerva 1990). I would like to propose that the negative marker is placed in this preverbal focus position. Note the inherent contrastive sense of negation. Interestingly, the contrastively focused or wh-phrases share stress properties with the negative marker. Thus, the wh-phrase is stressed in (21a) and it blocks the phrase-level stress rule, End Rule Left, from applying to the element on its left in (21b). Note that if both the wh-phrase and the negative marker are present, the stress falls on the leftmost element, i.e. the wh-phrase (21c). I have also shown the syntactic structures for the examples, without worrying about details. FocP represents the Focus Phrase, which is home to the focussed elements.[12] Note that the negative marker (a clitic) starts off in the spec position of the FocP and later cliticizes to the verb.

(21) a. $[_{\text{FocP}}$ kojâ´ raft-i] Syntactic Structure
$[_{\text{PPhrase}}$ kojâ´ raft-i] Prosodic Structure
where went-2sg
"Where did you go?"

b. $[_{\text{AgrOP}}$ketâb-o $[_{\text{FocP}}$ kojâ´ gozâsht]] Syntactic Structure
$[_{\text{IPhrase}}$ketâb-o $[_{\text{PPhrase}}$ kojâ´ gozâsht]] Prosodic Structure
book-acc. where put
"Where did s/he put the book?"

c. $[_{\text{FocP}}$ kojâ´ $[_{\text{FocP}}$ na- raft-i]] Syntactic Structure
$[_{\text{PPhrase}}$ kojâ´ $[_{\text{PPhrase}}$ na- raft-i]] Prosodic Structure
where neg.-went-2sg
"Where did you not go?"

There is a difference, however, between wh-phrases and the negative marker. Whereas, the negative marker is a clitic and has to be attached to the verb, the wh-phrase is preferably placed at the left edge of the focus phrase (i.e. right after the subject); thus the contrast in (22).[13]

(22) a. ali chérâ ketâb mi-xun-e
Ali why book indic.-read-3sg
"Why does Ali read books (book-reads)?"

[12] Alternatively, the focussed elements could be put in the spec of vP. Whether multiple specs of vP or FocP are used is a technical detail irrelevant to the discussion here. For convenience' sake, I use FocP throughout.
[13] There are a handful of exceptions to the word-final stress rule, including the word for "why". The word-level stress is not at issue here.

b. ali ketâb né-mi-xun-e

Ali book neg.-indic.-read-3sg

"Ali doesn't read books."

Based on the proposal made in this section, the negative marker is initially placed in the same position as the wh-phrase, i.e. at the left edge of the focus phrase (or FocP). If we allow possibilities such as the one discussed for the Ezafe construction in the previous section, we can argue that the negative marker receives its stress according to the general phrasal stress rule when it is the leftmost element in the phrase and it later cliticizes to the verb, leading to the stress pattern in (22b).[14] There is, however, a fundamental difference between this proposal and the one made for the Ezafe construction. Cliticization is generally considered a PF rule. Thus, one can maintain the assumption that stress assignment is a PF rule, even though it applies prior to cliticization. The case of the negative marker does not pose a problem to the separation and the relative order of syntactic and phonological rules. The movement proposed for the noun in the Ezafe construction, on the other hand, was clearly a syntactic movement. Therefore, suggesting that stress assignment takes place prior to the movement necessarily questions the discreteness of the syntactic and the phonological components.

Further support for the proposal that cliticization occurs after stress assignment comes from examples like the one in (23). If we assume that stress assignment applies to the surface form in (23), and that the negative marker constitutes the edge of the phonological phrase, the stress on the wh-phrase would be difficult to account for. Recall that at the higher intonational phrase, the stress rule is End Rule Right and we would expect the main stress to fall on the negative marker, i.e. the leftmost phonological word in the rightmost Phonological phrase. Assuming that the negative marker starts off higher, and that the edge of the focus phrase is the edge of the phonological phrase, we would correctly predict that the stress would go on the wh-phrase, i.e. the leftmost phonological word of the rightmost Phonological phrase. The merge position of the wh-word and the negative marker are shown in (24). In (24), the leftmost element in the focus phrase is the wh-word which receives the final stress.

(23) ali chérâ ketâb-o na-xund

Ali why book-acc. neg.-read

"Why didn't Ali read the book?"

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[14] This way, we might in fact be able to explain the mysterious behavior of the progressive construction in Persian in that it can never be negated (**dâram ne-mi-xor-am* prog. neg.-indic.-eat-1sg "I am not eating"). It might be the case that the progressive element blocks the cliticization of the negative marker. Why the progressive marker, and not other elements, blocks the cliticization remains to be explained. To negate progressive sentences, the indicative form is used. The result, however, is ambiguous between a habitual and a progressive reading (*ne-mi-xor-am* neg.-indic.-eat-1sg "I am not eating/ I do not eat").

(24) [$_{\text{CP/IP}}$	ali	[$_{\text{FocP}}$ chérâ	[$_{\text{FocP}}$	na	ketâb-o	xund]]]	Syntactic Structure
[$_{\text{IPhrase}}$	ali	[$_{\text{PPhrase}}$ chérâ	[$_{\text{PPhrase}}$	na	ketâb-o	xund]]]	Prosodic Structure

5 Conclusion

The word-level stress rule is "End Rule Right" in Persian. According to this rule, the final syllable in a word takes stress. Contrary to the long-held belief that Persian stress assignment is sensitive to lexical category, this rule applies to all verbs, as well as nouns and adjectives. It was shown in this paper that the superficially unusual stress pattern of "prefixed" verbs can be accounted for if we make a distinction between the grammatical word and the phonological word, and differentiate word- and phrase-level stress rules in Persian. The phrase-level stress rule is "End Rule Left" and puts the stress on the initial word in a phonological phrase. In the case of the prefixed verbs, the "prefixes" enter the combination as phonological words and the apparent initial stress is the result of the phrase-level stress rule. It was also shown that the same pattern persists if more words are added to the verb phrase. We have thus been able to provide a unified account of Persian stress which is independent of lexical categories.

Note that there is still a fundamental difference between verb phrases and noun phrases, but one that is connected to their syntactic structure. It is generally accepted that verb phrases (VPs or CPs) have a more complicated structure than noun phrases (NPs or DPs). Note that verb phrases constitute a sentence and can thus form an intonational phrase (IPhrase). Noun phrases, on the other hand, only consist of phonological phrases. Leaving aside the details and the problematic cases discussed above, the prosodic structure of Persian noun and verb phrases and their mapping to syntactic structure can be given as in (25).[15]

(25) a. Noun Phrase

Syntactic Struc.: [$_{\text{DP}}$ Dem(onstrative)- Numeral [$_{\text{N}}$ N(oun)–cohering sufs]- non-cohering sufs]
Prosodic Struc.: [$_{\text{PPhrase}}$ [$_{\text{PWord}}$ Dem(onstrative)]- [$_{\text{PWord}}$ Numeral] [$_{\text{PWord}}$ N(oun)-cohering sufs] - non-cohering sufs]

b. Verb Phrase

Syntactic Struc.: [$_{\text{CP/IP}}$ Subj [$_{\text{FocP}}$ Focus- ...- Aspect- Mood [$_{\text{V}}$ Verb] - non-cohering sufs]]
Prosodic Struc.: [$_{\text{IPhrase}}$ Subj [$_{\text{PPhrase}}$ [$_{\text{PWord}}$ Focus]- ...-[$_{\text{PWord}}$ Aspect]-[$_{\text{PWord}}$ Mood] [$_{\text{PWord}}$ Verb] - non-cohering sufs]]

Let us first look at the Noun Phrase in (25a). Starting from the right edge and moving to the left, the non-cohering suffixes are ignored. The left edge of the phonological word is determined by the noun. The word-level stress rule puts the stress on the final syllable of this

[15] The syntactic structures of Persian noun and verb phrases have been simplified for ease of illustration. The syntactic details are tentative.

phonological word.[16] All the morphosyntactic elements to the left of the noun constitute phonological words of their own. The edge of the phonological phrase is mapped onto the edge of the DP (the whole noun phrase). At the phrase level, the stress goes on the leftmost element. Noun phrases lack a higher prosodic level (i.e. intonational phrase). Thus the last syllable of the leftmost word in a noun phrase takes the primary stress of the whole phrase.

Let us now turn to the verb phrase in (25b). Starting from the right edge and moving to the left, the non-cohering suffixes are ignored. The left edge of the phonological word is determined by the tensed verb. All the morphosyntactic elements to the left of these heads constitute phonological words of their own. The edge of the phonological phrase is mapped onto the edge the FocP in verb phrases.[17] As a result, in the absence of focussed elements (including the negative marker), the verbal prefixes take the phrasal level stress. Otherwise, the focussed element receives primary stress. Finally, the edge of this intonational phrase is determined by the edge of the clause. However, since the intonational phrase level rule is 'End Rule Right', the final stress in unaffected.

To summarize, I have shown in this paper, that if the syntactic differences between noun phrases and verb phrases are taken into consideration, their apparently problematic stress pattern in Persian falls out rather straightforwardly.

[16] In the case of the Ezafe Construction, this is the final syllable of the last adjective. See section 4.1 for details.
[17] If there is no focussed element, the edge of the vP (or MoodP, AspP, etc. if we allow more functional projections) would determine the left edge of the phonological phrase.

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Prosodic form and identity effects in German

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1. Introduction

Identity effects in phonology are deviations from regular phonological form (i.e. canonical patterns) which are due to the relatedness between words. More specifically, identity effects are those deviations which have the function to enhance similarity in the surface phonological form of morphologically related words. In rule-based generative phonology the effects in question are described by means of the cycle. For example, the stress on the second syllable in cond[ɛ]nsation as opposed to the stresslessness of the second syllable in comp[ə]nsation is described by applying the stress rules initially to the stems thereby yielding condénse and cómpensàte. Subsequently the stress rules are reapplied to the affixed words with the initial stress assignment (i.e. stress on the second syllable in condense, but not in compensate) leaving its mark in the output form (cf. Chomsky and Halle 1968). A second example are words like lie[p]los 'unloving' in German, which shows the effects of neutralization in coda position (i.e. only voiceless obstruents may occur in coda position) even though the obstruent should 'regularly' be syllabified in head position (i.e. bl is a wellformed syllable head in German). Here the stem is syllabified on an initial cycle, obstruent devoicing applies (i.e. lie[p]) and this structure is left intact when affixation applies (i.e. lie[p]los) (cf. Hall 1992). As a result the stem of lie[p]los is identical to the base lie[p].

While accounting for phonological resemblance between related words in the examples illustrated above identity is always epiphenomenal on the cyclic approach (cf. Benua 1997). That is, cyclic rule application does not have the purpose to enhance surface similarity between related words; there is nothing desirable about such similarity. The manifestation of cyclic effects in surface forms is no more remarkable than the destruction of such effects by subsequent rule application (e.g. in the noun explanation the cyclic stress preservation on the second syllable (i.e. expláin) is presumably lost as a result of subsequent destressing rules applying in open syllables). In fact, the notion of the "Strict Cycle" generally causes distinctness in the surface forms of related words. For example, Trisyllabic Laxing is said to apply in serenity because of the synchronic relatedness to serene but it does not apply in nightingale because the relatedness between nightingale and night is said to no longer be recognized by the speakers. In cases like these cyclic rule application accordingly results in the opacity rather than enhancement of transparency between surface forms of related words (i.e. ser[ɛ]nity - ser[i:]ne).

By contrast, in Optimality Theory the relevant deviations from regular phonological form can be conceptualized as violations of phonological constraints which result from the satisfaction of a higher-ranking 'correspondence' constraints, which require identity of surface forms (cf. Benua 1995, McCarthy and Prince 1995, Raffelsiefen 1995). Conceptually, this approach is close to the traditional view of leveling in that strictly phonological constraints and identity constraints are recognized as inherently conflicting constraints on surface forms. Reference to identity constraints captures the traditional insight that the phonological form of words is subject to constraints which require identity of (surface) form with respect to related words.[1] Accounting for identity effects in terms of ranked constraints differs from the traditional view in that identity (or leveledness) is not seen as a 'repair' strategy to 'clean up' the phonological opacity within paradigms which results from fossilized historical sound changes (cf. Leskien, Brugmann, Osthoff and Brugmann). Rather, identity constraints can dominate phonological constraints thereby 'protecting' the leveledness of paradigms from being rendered opaque by sound changes. These are of course empirical issues to be resolved on the basis of historical studies.

In this paper I will investigate prosodic identity effects in German inflected adjectives and argue that such effects are best described in terms of the interaction of a constraint on paradigmatic levelling and certain prosodic wellformedness constraints. To prove the point it is necessary to clarify principles of prosodic wellformedness in German, especially those which relate to the distribution of schwa and principles of syllabification. An important distinction to be drawn is that between genuine identity effects, i.e. effects with a paradigmatic dimension and 'domain effects', which superficially resemble identity effects but are purely epiphenomenal in that they are determined by similarities in syntagmatic prosodic structure. For example, surface identity of German <u>lie</u>[p] and <u>lie</u>[p]los is conditioned by the fact that pwords constitute the domain of syllabification and consonant-initial suffixes are not integrated into the pword of the stems, but rather form their own pword. The relevant pword structures are hence $(\text{lie[p]})_\omega$ and $(\text{lie[p]})_\omega(\text{los})_\omega$. That is, the identical syllabification of the [p] in coda position in these two words does not presuppose any type of association between <u>lieblos</u> and <u>lieb</u> by the speaker but follows entirely from 'alignment constraints' which align pword boundaries with morphological boundaries and syllable boundaries with pword boundaries.

To establish the properties of genuine identity effects it is necessary to exclude all domain effects. This point as well as other generally neglected factors which need to be considered before identiy effects can be established are discussed in section 2. In section 3 I will review previous work on the distribution of schwa in German, emphasizing the inadequacies which result from the rule-based cyclic approach. In section 4 I will identify 'regular' patterns of schwa distribution and syllabification in German by investigating the evidence from sound change (i.e. the context-sensitivity in schwa loss and glide formation). The goal of this section

[1] In cases of so-called contamination the words in question need not be morphologically (or etymologically) related. Well-known examples include the replacement of [ð] for [d] in English <u>father</u>, to enhance similarity to the words <u>mother</u> and <u>brother</u>. The phenomenon is especially common in basic number terms where it always involves consecutive numbers, (e.g. the replacement of Germanic [p] for [hw] in <u>petwor</u> 'four' in analogy with <u>pempe</u> 'five' (cf. Greek tetra 'four', pente 'five'), the replacement of Russian [d] for [n] in <u>dev'at'</u> in analogy with <u>des'at'</u> 'ten'). The changes always serve to enhance similarity in the surface forms of related words.

is to establish a ranking of constraints which describes systematic preferences for syllable structure and conditions for the occurrence of dactyls in German. In section 5 it will be shown how deviations from these regular patterns in inflected words can be described in terms of the interaction between phonological constraints and identity constraints.

2. The recognition of identity effects: things to consider

2.1. The proper basis for establishing identity effects

To establish deviations from the regular sound patterns of a language it needs to be clarified how to identify such patterns. Obviously deviations can only be established on the basis of those words whose sound patterns are uninfluenced by related words. While proper nouns (names) may appear to be prima facie examples of such words (cf. the well-known example Tatamagouchi to prove the existence of a cyclic effect in words like originality) there is evidence that they ought to be excluded from consideration. That is, names (and interjections) can often be shown to deviate from regular sound patterns, perhaps to enhance their perceptual salience. For example, there has been a historic tendency for four syllable English nouns which end in a liquid to develop initial main stress (e.g. sàlamánder > sálamànder, òleánder > óleander, polyéster > pólyester). The opposite tendency exists for names (Álexànder > Àlexánder). On the basis of the regular sound patterns in nouns like sálamànder it can be established that the stress contour in the noun rècomménder qualifies as a genuine identity effect (with respect to the base recomménd). This insight would be obscured if the sound patterns of names (e.g. Àlexánder, Madagáscar, Ebenézer) were used to establish identity effects.[2]

While reference to underived common words is the ideal basis for establishing identity effects the paucity of relevant examples can make it necessary to consider derived words as well. However, one has to be careful to exclude derived words which themselves exhibit identity effects. A well-known example is the pair condensation – compensation cited above. While it seems reasonable to invoke the notion of an identity effect to explain the distinct stress patterns in these words it is not clear that *both* words exhibit identity effects. In fact, reference to phonologically comparable words which lack a base and therefore do not exhibit identity effects such as chìmp[æ]nzée, sèr[ɛ]ndípity reveals that only the stress pattern of compensation is deviant. This is because, condensation is like chimpanzee or serendipity in that the second syllable, which is closed by a nasal, can bear secondary stress but can also reduce to a schwa syllable. By contrast, the second syllable in compensation cannot bear secondary stress, apparently because such stress would violate the identity to the base compensate. The conclusion that only compensation, but not condensation, exhibits identity effects is significant in that only compensation can be synchronically derived by suffixation. This example thus supports the claim that underived common words are the ideal basis for

[2] For more examples see Raffelsiefen 1993:90ff.

establishing identity effects.

A third point to keep in mind when establishing identity effects is the possibility that words belonging to different syntactic categories may have different canonical patterns. For example, there are nouns in English which include a word-internal sequence of two unstressed syllables (e.g. cátamaràn, rígamaròle) but this canonical pattern does not exist for verbs. In verbs, such stress patterns are always identity effects (e.g. <u>hóspitalìze</u> – <u>hóspital</u>, <u>rádicalìze</u> – rádical).

2.2. Identity effects versus domain effects

In section 1 I argued that identity effects need to be distinguished from (superficially similar) domain effects, because the latter do not involve association of related words by the speaker. Rather, domain effects only indicate the recognition of affixes along with the appropriate alignment constraints. To support this argument I will first review the evidence for the claim that the domain of syllabification of complex words is determined by the phonological form and position of the affixes. In section 2.2.2 I will illustrate the distinction between domain effects and identity effects with some examples.

2.2.1. The domain of syllabification

There is evidence that the domain of syllabification in both English and German requires reference to morphological structure and certain phonological properties of affixes. Consider first the result of historical schwa loss in the German suffixed words in (1). The near-minimal pair (ver)gé[p]lich - né[b]lig shows that schwa loss correlates with devoicing of the preceding obstruent only if a consonant-initial suffix follows.

(1)	MHG vergëbe+lich 'forgive+Suf'	a.	vergé[bəl]ich > NHG vergé[pl]ich 'in vain'
	MHG nëbel+ic 'fog+Suf'		né[bəl]ic > NHG né[bl]ig 'foggy'

The evidence from sound change in (1) correlates with the evidence from word formation. New coinages by -<u>lich</u>-suffixation which involve the truncation of stem-final schwa also show obstruent devoicing as is illustrated in (2).[3]

[3] The adjective [e:əlɪç] <u>ehelich</u> 'marital' derived from [e:ə] <u>Ehe</u> 'marriage', which is the only case where a stem-final schwa is preserved, supports the claim that consonant-initial suffixes are not integrated into the pword of the stem. This is because the exceptional preservation of schwa serves to satisfy a constraint against prosodic words consisting of a single segment. This constraint concerns neither moraic structure as is shown by the existence of words like [ze:] <u>See</u> 'sea', [re:] <u>Reh</u> 'deer' nor 'X-slot'-structure as is shown by the existence of words consisting of single diphthongs (e.g. <u>Ei</u> 'egg', <u>Au</u> 'pasture'). The constraint in question is not obeyed in interjections (e.g. [a:] 'ah', [i:] 'i', [o:] 'oh', [e:] 'äh', in accordance with the fact that a good interjection violates wellformedness conditions for pwords (e.g. the interjections <u>hui</u> and <u>pfui</u>, which violate a constraint against rising diphthongs, the interjections <u>sch</u> and <u>pst</u> which violate a constraint against syllables without a sonorant nucleus).

(2) NHG Er[b]e+lich -> er[p]lich
'heritage+Suf'

Provided that the voicing contrast for German obstruents is neutralized in coda position (cf. the plural past tense forms tru[.g]en 'carried' vs. bu[.k]en 'baked' with the corresponding singular forms tru[k] - bu[k], in which the velar obstruent appears in coda position) the data in (1) and (2) indicate that vowel-initial, but not consonant-initial, suffixes are syllabified together with their stem. Assuming that the pword is the domain of syllabification this analysis can be expressed in terms of the structures in (3).

(3) (vergeb)$_\omega$(lich) (neblig)$_\omega$

Suffixes which consist only of consonants and therefore cannot form a syllable are integrated into the pword of the stem as is shown in (4). The syllabification of consonantal affixes is hence indistinguishable from the syllabification of corresponding consonants in underived words. Also phonological rules which are sensitive to syllable structure affect both types of words alike. For example, vowel lengthening before tautosyllabic clusters consisting of r plus a coronal stop applied both in Bart (i.e. B[a]rt > B[a:]rt) and the suffixed word Fahrt (i.e. F[a]rt > F[a:]rt):

(4) Fahr+t -> (Fahrt)$_\omega$ Bart -> (Bart)$_\omega$
'ride+Suff' 'beard'

Turning now to prefixes we find that historical devoicing in (5a) and the occurrence of glottal stops in the vowel-initial stems in (5b) indicate that prefixes are not integrated into the pword of the stem. Again, the prosodic representation of the prefixes is ignored here (for discussion, see Hall (1999), Raffelsiefen (2000))

(5)a.	ab-	MHG. aberede > NHG A[p]rede	A[p](rede)$_\omega$
	ob-	MHG obeliegen > NHG o[p]liegen	o[p](liegen)$_\omega$
b.	auf-	auf[ʔ]essen	auf([ʔ]essen)$_\omega$
	er-	er[ʔ]ahnen	er([ʔ]ahnen)$_\omega$
	ent-	ent[ʔ]eignen	ent([ʔ]eignen)$_\omega$

For prefixes it also holds that their integration can be determined by their phonological form as is shown by s-prefixation in English. Note that stops are aspirated in syllable-initial position, but are unaspirated after s. The fact that the stem-initial stops in (6) are unaspirated shows that the prefix is syllabified together with the stem.

(6)	s+[t^h]rample 'trample'	s[t]rample 'strample'	(cf. s[t]reet 'street')
	s+[k^h]runch 'crunch'	s[k]runch 'scrunch'	(cf. s[k]ream 'scream')
	s+[p^h]lunge 'plunge'	s[p]lunge 'splunge'	(cf. s[p]leen 'spleen')

Because it is output-oriented the parenthesized condition in (11) violates the spirit of generative phonology. That condition, however, is necessary to prevent S-schwa-epenthesis from applying to sichern or dunkeln (i.e.*sich[ə]r[ə]n, *(ver)dunk[ə]l[ə]n) and also to prevent "L-schwa-epenthesis" from applying to syllabifiable verb stems like faul- 'rot' or quirl- 'whisk' (*fau[ə]l-, *quir[ə]l-.

Consider next the agentive nouns in (12):

(12) (Ver)sich[ə]r[ə]r 'insurer'
(Ver)dunkl[ə]r 'darkener'
Trockn[ə]r 'drier'

As is shown by the pair (ver)dunk[ə]ln - (Ver)dunkl[ə]r the application of L-epenthesis to the stem (ver)dunkl- depends on the suffix: the rule applies if -n is subsequently attached but not if -r is attached. This type of "global" dependency could be accounted for by extrinsically ordering r-suffixation before L-schwa-epenthesis as is illustrated in (13).[6]

(13)	(ver)dunkl-]$_V$	(ver)dunkl-]$_V$	trockn-$_V$	trockn-]$_V$	
	(Ver)dunklr]$_N$		Trocknr]$_N$		r-suffixation
	(Ver)dunkl[ə]r]$_N$	(ver)dunk[ə]l-]$_V$	Trockn[ə]r]$_N$		L-schwa-epenthesis
		(ver)dunk[ə]ln]$_V$		trocknn]$_V$	n-suffixation
				trockn[ə]n]$_V$	S-schwa-epenthesis

While yielding correct output forms in the cases considered so far the analysis presented above is somewhat redundant. The redundancy concerns the inherent sonority of the suffixes and their relation to the sonority specification of the consonants triggering schwa-epenthesis. The key to correct schwa insertion is to specify the epenthesis-rules such that the sonority of the rule-triggering class (e.g. the class of liquids) does not exceed the sonority of the suffix to be attached next. This approach obscures the observation that the distribution of the schwa in (9) and (13) depends strictly on the sonority relations among the consonants in the 'output' regardless of whether or not those consonants are suffixes. The relevant generalization is that the schwa prevents 'sonority violations' in syllable codas by 'breaking up' the rightmost cluster in which sonority fails to decrease (e.g. the boldfaced clusters in (14)).

(14) (Ver)dun**kl[ə]r**, (ver)dun**k[ə]l**n, Troc**kn[ə]r**, troc**kn[ə]n**

Sonority relations are determined with respect to the hierarchy in (15), which will be refined in section 4.

[6] Both the suffix -r and the suffix -n attach only to verb stems which renders superfluous additional ordering restrictions.

(15) increasing sonority decreasing sonority

<--->

Vowels	r	l	Nasals	Fricatives	Stops

The empirical inadequacy of the rule-ordering approach, which merely mimics the relevance of the sonority relations of *all* consonants in the fully derived word by clever rule ordering, is revealed by words in which the schwa is followed by a sequence of consonants C_iC_j, where C_j is not a suffix. Again the schwa breaks up the the rightmost cluster in which sonority fails to decrease (e.g. the boldfaced clusters in (16)). That is, in (16) the schwa also has the function of making the words 'syllabifiable' but none of the epenthesis rules allows for this generalization to be expressed.

(16) hun**d[ə]rt** 'hundred', **Ab[ə]nd** 'evening', Ge**g[ə]nd** 'area', tau**s[ə]nd** 'thousand', **Jug[ə]n**d 'youth', **Tug[ə]nd** 'virtue', al**b[ə]rn** 'silly', buss**[ə]rl**n 'to kiss', ges**t[ə]rn** 'yesterday', Ga**ll[ə]rt** 'jelly'

German differs thus from English, where simplexes contrast with respect to the site of the schwa. That is, the schwa may either break up the rightmost cluster for which sonority increases as in (17a) or follow that cluster as in (17b):

(17)a. stan**d**[ə]**r**d 'standard' b. hun**dr**[ə]d 'hundred'
pa**t[ə]r**n 'pattern' pa**tr**[ə]n 'patron'
ta**v[ə]rn** 'tavern' che**vr**[ə]n 'chevron'
sa**t[ə]rn** 'Saturn' a**pr**[ə]n 'apron'
ci**t[ə]rn** 'cittern' ci**tr**[ə]n 'citron'

While the patterns in (17b) exist also in German there is a crucial restriction on their occurrence which has gone unnoticed in previous work. That is, the pattern in (17b) occurs only in certain inflected word forms and is always conditioned by paradigmatic leveling and qualifies therefore as an identity effect. In the remaining German words, including all uninflected words, schwa never occurs in the site illustrated in (17b). Wiese (1996:244) is thus wrong when he asserts that in German "instead of *hundert*, we could just as well have *hundret* (cf. English *hundred!*[7])". Wiese has to resort to an English example to back up his claim because such patterns do not occur in German uninflected words. His misstatement of the facts is symptomatic for other LP work as well in that syllabifiability (i.e. sonority relations) is the only phonological condition on schwa epenthesis which is recognized.[8]

[7] The exclamation mark is Wiese's.

[8] While invoking syllabifiability in (4) Wiese 1988 emphasizes that syllabic wellformedness alone does not account for the site of the schwa in (16). He argues that while preference for widm[ə]n over *wid[ə]mn could indeed be explaimed with reference to syllabic wellformedness non-occurring verbs like *klettr[ə]n would be equally acceptable as klett[ə]rn as far as syllable structure is concerned.

but not the one in between, i.e. the l. This particular problem is characteristic of inflected adjectives in German and will henceforth be referred to as the "sonority puzzle".

The suspicion that the true factor determining the distribution of the schwa in (21) is not strictly phonological is enhanced by the observation that the schwa patterns are identical for all adjectives belonging to the same paradigm. A paradigm is here defined as the set of the inflected forms of a word whose distribution is determined solely by agreement with another element within some grammatical configuration. In German the forms of attributive adjectives depend on the preceding determiner (definite, indefinite, or none), as well as on case, number, and gender within the determiner phrase. Due to considerable syncretism there are only five distinct forms in each paradigm as is illustrated in (22):

(22) ein **dunkles**]$_{\text{AINFL}}$ Brot
'a dark bread'
das **dunkle**]$_{\text{AINFL}}$ Brot
'the dark bread'
statt **dunkler**]$_{\text{AINFL}}$ Brote
'instead of dark breads'
mit **dunklem**]$_{\text{AINFL}}$ Brot
'with dark bread'
die **dunklen**]$_{\text{AINFL}}$ Brote
'the dark breads'

Adjectives in predicative position are not inflected and are therefore not part of the paradigm in (22) (e.g. Das Brot ist dunkel. 'The bread is dark.' Die Brote sind dunkel. 'The breads are dark.'). The point of interest here is that all members of an adjectival paradigm have identical phonological forms except for the word-final consonant, that is, the suffix. In particular, they never differ with respect to either the number or the sites of schwas. Perfect leveling in adjectival paradigms is without exceptions. In contrast to other inflectional paradigms in German there is no suppletion of any kind.[11]

(23)	dunkl[ə]s	trock[ə]n[ə]s	lock[ə]r[ə]s	makabr[ə]s
	dunkl[ə]	trock[ə]n[ə]	lock[ə]r[ə]	makabr[ə]
	dunkl[ə]r	trock[ə]n[ə]r	lock[ə]r[ə]r	makabr[ə]r
	dunkl[ə]m	trock[ə]n[ə]m	lock[ə]r[ə]m	makabr[ə]m
	dunkl[ə]n	trock[ə]n[ə]n	lock[ə]r[ə]n	makabr[ə]n

The 'sameness' of the schwa patterns in (23) cannot be explained on strictly phonological grounds. Certain illformed paradigms like the one given in (24) have better syllable structures because in each inflected form the schwa breaks up the rightmost cluster in which sonority fails to decrease.

[11] In fact, even the paradigms of adjectives ending in an unstressed full vowel, which are exceptional in that they take no endings, are perfectly leveled.

(24) * dunk[ə]ls
dunk[ə]l
dunkl[ə]r
dunk[ə]lm
dunk[ə]ln

Preference for the leftmost paradigm in (23) over the one in (24) follows from the essentially morphological condition of 'leveled' paradigms (cf. Vennemann 1982:289)[12]. The relevant generalizations cannot be adequately expressed in rule systems for which individual inflected words are the domain of description. Once leveling is recognized as a wellformedness condition for paradigms, the occurrence of schwa before stem-final r or nasal, but not before l (i.e. "the sonority puzzle") follows from the independent fact that r and n are adjectival inflectional suffixes whereas l is not. This connection between leveling and the inventory of suffixes will be made precise in section 5. Also, the "celebrated minimal pair" (Rubach 1990:88) in (25) will be shown to follow straightforwardly from the condition that paradigms must be leveled.

(25) dunkl[ə]n]$_{AINFL}$ - Dunk[ə]ln]$_{NINFL}$

As will be shown in section 5, the different sites of the schwa in (25) follow from the fact that adjectival paradigms include a suffix which is more sonorous than l, e.g. the suffix r, whereas the most sonorous suffix in the nominal paradigm, e.g. the nasal n, is less sonorous than l:

(26)

adjectival paradigm:	nominal paradigm:
dunkl[ə]s	Dunk[ə]l
dunkl[ə]	Dunk[ə]l**n**
dunkl[ə]**r**	Dunk[ə]ls
dunkl[ə]m	
dunkl[ə]n	

The data in (26) have led many to posit that adjectival, but not nominal inflectional suffixes, are lexically represented as "ə(C)" (cf. Strauss (1982)[13], Becker (1990)[14], Féry (1991), Noske (1993)). This stipulation expresses a correct surface generalization since adjectival suffixes are indeed invariably associated with schwa. However, as will be shown association

[12] Vennemann (1982) argues that the site of the schwa in inflected German verbs is historically determined by "Systemzwang" i.e. paradigmatic leveling.
[13] Strauss (1982) who describes the distribution of German schwa in terms of deletion rules stipulates that schwas preceding adjectival suffixes are 'undeletable'.
[14] Becker writes that for stems which end in the sequence schwa plus sonorant, suffixes remain syllabic in adjectival inflection, whereas in the nominal inflection the nonsyllabic allomorph is chosen (1990:131).

with schwa in (26) is not a property of adjectival suffixes per se but follows from their sonority (i.e. the inventory of adjectival inflectional suffixes - unlike those of other categories - include a liquid) and from the condition of paradigmatic leveling.[15]

3.3. Lexical versus epenthetic schwa

In generative descriptions epenthetic schwas are distinguished from lexical schwas. The occurrence of the former is determined by applying rule (11) as is illustrated in (27a). The latter schwas are already present in underlying representations as is illustrated in (27b).

(27)a.	sichr	sich[ə]r	b.	Tug[ə]nd
	Wackr	wack[ə]r		Gall[ə]rt
	Eifr	Eif[ə]r		alb[ə]rn

As was pointed out above, the schwa in both types of words is equally "predictable" in that they "break up" the rightmost cluster with decreasing sonority in the respective words. While some generative linguists would argue that both schwas should be treated as epenthetic (cf. Wiese 1988)[16] there is presumably a consensus that word-final schwas are always lexical. However, there are problems for the concept of the underlying level as repository for unpredictable information here as well. Specifically, there are certain types of words where word-final schwas are almost always preceded by a voiced obstruent. One such type is the class of adjectives; illustrated in (28):

(28) träg[ə] 'lazy', öd[ə] 'barren', bö[z][ə] 'mad', prüd[ə] 'prudish', frigid[ə] 'frigid', solid[ə] 'solid', mürb[ə] 'crumbly', lei[z][ə] 'quiet'

The words in (28) are similar to those in (27) in that they are unpronounceable without the schwa. In both cases the unpronounceability is due to constraints on syllable codas which are inviolable in German. Without the schwa the words in (27) include a coda with increasing sonority whereas those in (28) include a coda with voiced obstruents. Why then could the schwas in (28) not be analysed as epenthetic to ensure pronounceability in parallel with the schwas in (27)?

(29)a. si[çr] → si[çər] 'sicher' b. trä[g] → trä[gə] träge

The problem for the parallel treatment of the cases illustrated in (29) lies in the use of two ontologically distinct sources for determining underlying forms. That is, underlying forms do

[15] It is true that adjectival inflectional endings are also preceded by schwa in cases where no member of the paradigm requires schwa for phonological reasons (e.g. roher [ro: ər] 'raw', zäher [tse: ər] 'tough'). However, the relevant generalization here is that words with a sonorant suffix regularly end in a schwa syllable in German including words derived with the agentive suffix -r (e.g. [se:ər] Seher 'seer'), the diminutive suffix -l (e.g. Greu[ə]l 'horror', the infinitival suffix -n [se:ən] sehen 'see'), and others.

[16] Wiese 1988 assumes that the schwa in the cases in (27b) is followed by two consecutive suffixes. This is obviously an ad hoc solution.

not only have the function of representing information which is not predictable on phonological grounds. In addition they have the function of providing unitary forms for alternations in morphologically related words. It is the second function which distinguishes the cases in (29) since there are two types of obstruent-final adjectives as is illustrated in (30):

(30)a. har[t] har[t]er 'hard' b. kar[k] kar[g]er 'barren'

To account for the alternation between voiceless and voiced obstruents in the related forms in (30b) versus the lack of alternation in (30a) the relevant obstruents are distinguished in underlying forms as follows:

(31)a. har/t/ b. kar/g/

If this analysis, which is motivated by considerations of parsimony in the lexicon, is accepted the parallel treatment of the schwas in (29a) and (29b) is no longer possible. This is because underlying representations like trä/g/ and kar/g/ would no longer allow for the 'epenthesis- cases' in (29b) to be distinguished from the 'alternation-cases' in (31b). To avoid this problem, nothing is said about the phonological conditioning of the final schwas in (28) in rule-based generative descriptions in that they are analysed as 'lexical', that is, 'unpredictable'. This problem will be solved in the constraint-based description in section 4.

To summarize, previous descriptions of schwa patterns have been inadequate in three respects. First, the description of phonological conditions on schwa occurrence suffers from two problems. While it is recognized that the distribution of schwa has to do with syllabifiability the domain for the epenthesis rules is misstated. A proper description of schwa requires reference to the phonological word (i.e. the stem plus all consonantal and vowel-initial suffixes) rather than stems. In addition the conditions for schwa epenthesis are insufficient in that they refer only to sonority (i.e. syllabifiability) to the exclusion of all other constraints on syllabic wellformedness (e.g. constraints on head complexity, constraints on the form of syllable shells). The relevant generalizations, which pertain to the syllable structure of (morphologically complex) phonological words, are obscured by spurious reference to morphosyntactic structure and level distinctions. Second, the fact that putatively phonological epenthesis rules conspire to yield leveled paradigms is treated as a coincidence. In general, analogical influences are not considered in LP descriptions on German schwa. Third, the distinction between "epenthetic" and "lexical" schwas obscures the fact that the occurrence of both types is governed by phonological conditions.

4 Canonical patterns

It is the purpose of this section to establish canonical prosodic patterns in German to provide a basis for recognizing identity effects. Methodologically I will primarily evaluate the evidence from recent sound changes and patterns of loan word adoption to establish those patterns. The sound changes include schwa loss and Glide Formation. It will be shown that the context-sensitivity of those sound changes is best described in terms of as system of ranked constraints. The rankings in question describe principles of syllabification and the conditions for the occurrence of dactylic feet in German.

4.1 The constraint *SCHWA

While all unstressed vowels reduce to schwa in the transition from OHG (Old High German) to MHG (Middle High German) only a subset of those schwas have disappeared in NHG (New High German).[17] The glosses refer to the current meanings:

	OHG	MHG	NHG	
(32)	gimáhalo	g[ə]máh[ə]l[ə]	G[ə]mahl	'spouse'
	giná:da	g[ə]nád[ə]	Gnad[ə]	'mercy'
	hánaf	hán[ə]f	Hanf	'hamp'
	óvan	óv[ə]n	Of[ə]n	'oven'

Assuming that every language change amounts to a "local improvement" (cf. Vennemann 1988) the question arises in what respect the NHG forms are better than the corresponding MHG forms. The relevant constraint is tentatively stated in (33) (cf. Mester and Ito (1994)):

(33) *SCHWA
Schwa is prohibited.

Evaluation of candidate forms with respect to the constraint *SCHWA is illustrated with MHG g[ə]lükk[ə], NHG Glück 'luck' in (34):

(34)	Input			*SCHWA
	g[ə]lükk[ə]		g[ə]lükk[ə]	**
			g[ə]lükk	*
			glükk[ə]	*
		→	glükk	

Not all schwas disappeared (cf. the data in (32)), which shows, that *SCHWA is violable.[18] In the remainder of this chapter it will be shown that the stability of schwas can be described in terms of satisfaction of independently motivated constraints.

4.2 The VOICE stability effect

[17] The data are based on Lexer (1878) and Drosdowski (1989).

[18] The constraint *SCHWA was never violated in OHG, which shows that it was undominated then. Vowel reduction in MHG indicates that *SCHWA came to be dominated by a prosodic constraint which expresses a preference for a single stressed syllable within the prosodic word.

Assuming that schwa loss after sonorants or voiceless obstruents in the adjectives in (35a) serves to satisfy *SCHWA the question arises of why schwa remained after voiced obstruents as shown in (35b).

(35)	OHG	MHG	NHG	
a.	chálo	kal[ə]	kahl	'bald'
	hréini	rein[ə]	rein	'clean'
	sámfto	sanft[ə]	sanft	'gentle'
b.	múodi	müed[ə]	müd[ə]	'tired'
	trá:gi	træg[ə]	träg[ə]	'sluggish'
	lí:so	lei[z][ə]	lei[z][ə]	'quiet'

According to Wilmanns (1911:364) the deletion patterns in (35) have historically been related to the absence of voiced obstruents in syllable-final position in German (cf. Adelung 1781). The constraint in question can be formulated as follows (cf. Shibatani 1973):

(36) CODA VOICE
Voiced obstruents in coda position are prohibited.

Tableau (37), which compares forms with schwa with the corresponding schwaless forms, shows that the ranking CODA VOICE >> *SCHWA accounts for the data in (35). The examples in (37a,b,c) represent words in which the final schwa is preceded by a voiceless obstruent, a sonorant, and a voiced obstruent, respectively. The exclamation mark indicates a "fatal" violation, which leads to the elimination of the candidate.

(37)		candidates	CODA VOICE	*SCHWA
a.		dick[ə]		*!
	√	dick		
b.		rein[ə]		*!
	√	rein		
c.		træg	*!	
	√	træg[ə]		*

The fact that CODA VOICE is never violated in German has led proponents of rule-based approaches to conclude that there is an automatic rule of "Final Devoicing" in German. The observation that the final schwa in words like træg[ə] has been stabilized by the illformedness of the form træ[g] argues against the existence of such a rule. Yet the question arises of what rules out the "devoiced" candidate træk. This candidate cannot be eliminated on phonological grounds but rather calls for a different type of constraint which relates candidates to input forms. Ranking the constraint PRESERVE VOICE stated in (38) higher than *SCHWA yields the desired effect:[19]

(38) PRESERVE VOICE
The feature [±voice] must be preserved

Tableau (39) shows how the ranking of the three constraints considered so far accounts for the preference of schwaless forms unless the schwa is preceded by a voiced obstruent.[20]

(39)	Input		candidates	CODA VOICE	PRESERVE VOICE	*SCHWA
a.	dick[ə]		dick[ə]			*
		√	dick			
b.	rein[ə]		rein[ə]			*
		√	rein			
c.	træg[ə]		træg	*!		
			træk		*!	
		√	træg[ə]			*

All input forms in (39) end in schwa to match the historical starting point of schwa deletion. Specifically, the input forms in (39) represent the surface forms which were historically encountered in language acquisition. The constraint ranking accounts for the forms selected by learners on the basis of those input forms, which then surfaced in their own speech (i.e. the forms dick, rein, and træg[ə] in (39)). "Schwa deletion" thus refers to an era when learners were more likely to encounter words ending in schwa than to render that schwa in their own speech with the result that input forms like dick[ə] and rein[ə] were eventually replaced by the restructured forms dick and rein.

Consider now the rare cases of adjectives in which schwa deleted despite being preceded by a voiced obstruent. The adjectives elend and fremd differ from the other adjectives under consideration in that they consisted of a ternary foot in MHG (i.e. MHG éllènde, vrémede) provided that a foot consists of a stressed syllable and the following less stressed syllables within the phonological word.[21] The tendency in German not to exceed binary feet was

[19] This description raises the question of whether or not the Voice Stability Effect is contingent on the fact that [±voice] is a contrastive feature in German. Consider noncontrastive features like aspiration or glottalization in American English: voiceless stops are aspirated in onset position but glottalized in coda position. Could there for example exist a stability effect in American English which is based on the constraint against aspirated stops in coda position? I suspect that such an effect could not exist but that contrastiveness is a crucial prerequisite for stability effects.

[20] In words like strenge 'strict', enge 'narrow', and bange 'anxious' word-final schwa deleted presumably *after* postnasal g-deletion occurred (e.g. stre[ŋgə] > stre[ŋə] > stre[ŋ]). This is because, unlike the obstruent [g], the nasal [ŋ] is unmarked for the feature [±voice] in coda position and therefore does not stabilize the following schwa. The deletion of final schwa in those words argues against the analysis proposed by Hall (1992) and Wiese (1994) who derive the velar nasal *synchronically* from an underlying cluster /ng/.

[21] In accordance with the prosodic hierarchy feet are limited by phonological word boundaries. The words in (i)

already observed by Heyse (1838). His observation can be stated in terms of the following constraint:[22]

(40) $(\sigma^2)_F$
Feet must be maximally binary.

The fact that schwa systematically deleted after voiced obstruents in words consisting of ternary feet indicates that the constraint $(\sigma^2)_F$ dominates PRESERVE VOICE. Recall that *CODA VOICE is never violated in MHG and NHG:

(41)	Input		candidates	CODA VOICE	$(\sigma^2)_F$	PRESERVE VOICE	*SCHWA
			éllènd	*!			
	éllènd[ə]		éllènd[ə]		*!		
		√	éllènt			*	

The tableau in (41) illustrates the general form of a schwa stability effect. Both a constraint on syllable wellformedness and a constraint on preservation dominate *SCHWA. Schwa stability effects can be obscured because of higher-ranking constraints on the maximal number of syllables allowed within prosodic constituents.

From a historical point of view the description of the VOICE Stability Effect in terms of the constraint ranking in (41) is superior to a description in terms of a schwa deletion rule which would require disjunct rule ordering (sonorants and voiceless obstruents do not constitute a natural class). All constraints in (41) can be motivated independently. The constraint ranking in (41) also has synchronic significance: it accounts not only for the synchronic stability of schwas which are preceded by a voiced obstruent but also accounts for the adoption of loan words. The fact that schwas have been stabilized by preceding voiced obstruents but are never inserted to preserve voicedness in obstruents (e.g. Ba[g]da[d] is adopted as Ba[k]da[t], rather than Ba[gə]da[də]) shows furthermore that PRESERVE VOICE is dominated by a constraint against epenthesis in German.

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differ from words like éllènde, vrémede in that they consist of two phonological words. The schwa in (i) is therefore stable according to the ranking in tableau (39), although the stress contour of those words is similar to that of historically fused compounds like éllènde, in which the schwa disappeared:

(i)	MHG > NHG	
	$(\text{snít})_\omega(\text{kàese})_\omega$ > $(\text{Schnítt})_\omega(\text{käs[ə]})_\omega$	'sliced cheese'
	$(\text{glás})_\omega(\text{òuge})_\omega$ > $(\text{Glás})_\omega(\text{àug[ə]})_\omega$	'glass eye'
	$(\text{vür})_\omega(\text{sòrge})_\omega$ > $(\text{Für})_\omega(\text{sòrg[ə]})_\omega$	'welfare'
	$(\text{úr})_\omega(\text{kùnde})_\omega$ > $(\text{Úr})_\omega(\text{kùnd[ə]})_\omega$	'document'

[22] The constraint in (40) differs from the constraint FTBIN in Prince and Smolensky in that it imposes an upper limit on the size of feet rather than require binary feet. This modification is necessary to account for the general preference of monosyllabic over trochaic forms in German.

4.3 The SON Stability Effect

Assuming again that schwa loss in the adjectives in (42a) serves to satisfy *SCHWA the question arises of why schwa remained in (42b).

(42)	OHG	MHG	NHG	
a.	kárag	kar[ə]c	karg	'meagre'
	érnust	ern[ə]st	ernst	'serious'
	sóli:h	sol[ə]ch	solch	'such'
b.	mágar	mag[ə]r	mag[ə]r	'lean'
	óffan	off[ə]n	off[ə]n	'open'
	túnkal	tunk[ə]l	dunk[ə]l	'dark'

It appears that the relevant difference between the words in (42a) and (42b) concerns the sonority relation between the consonants which flank the schwa. Specifically, in the words in (42a) the schwa is preceded by a sonorant and followed by an obstruent whereas the opposite order is found in the words in (42b). Schwa loss would accordingly yield a cluster with decreasing sonority in (42a), but not in (42b). As a result schwa loss in (42b) would yield a violation of a constraint on sonority defined in (43) (cf. also Sievers 1901).[23]

(43) SON
A segment in the syllable head may only be followed by segments of higher sonority; a segment in the syllable coda may only be preceded by segments of higher sonority.

That is, for every segment in the syllable shell (i.e. head and coda) the sonority level must increase toward the nucleus. The constraint in (43) is evaluated with respect to the sonority hierarchy tentatively stated in (15). The deletion patterns in (42) are described by ranking the constraint SON above *SCHWA as is illustrated in (44):

(44)	Input:			SON	*SCHWA
a.	kar[ə]c		kar[ə]c		*!
		→	karc		
b.	mag[ə]r	→	mag[ə]r		*
			magr	*!	

To rule out candidates like <u>mag</u> or <u>mar</u>, which violate neither SON nor *SCHWA, I will refer to the constraint PRESERVE C stated in (45):

(45) PRESERVE C
All consonants in the input must be preserved in the output.

[23] Those laws say that the more sharply the sonority increases towards the nucleus the more syllable heads and codas are preferred (cf. Vennemann 1988:13ff).

In contrast to SON, the constraint PRESERVE C has been violable in German as is shown by historical developments like MHG we[rlt] > NHG We[lt] 'world', MHG la[mp] > NHG La[m] 'lamb', etc.

(46)	Input:			SON	PRESERVE C	*SCHWA
			magr	*!		
	mag[ə]r		mar		*!	
		→	mag[ə]r			*

The need to distinguish PRESERVE C from PRESERVE VOICE is demonstrated by the fact that both schwas in dactyls are stable to satisfy PRESERVE C.

(47)	Input:			SON	PRESERVE C	$(\sigma^2)_F$
			Tugnd[ə]n	*!		
	Tug[ə]nd[ə]n		Tug[ə]ndn	*!		
			Tund[ə]n		*!	
		→	Tug[ə]nd[ə]n			

The rankings in (47) account for the similarities between 'epenthetic' and 'lexical' schwas described in section 3.3. in terms of stability conditions. That is, while the VOICE Stability Effect accounts for the historical stability and synchronic occurrence of schwas which are preceded by voiced obstruents the SON Stability Effect accounts for the historical stability and synchronic occurrence of schwas which are flanked by segments for which sonority increases.

4.4. Syllable complexity

Consider the patterns of schwa loss in dactyls illustrated in (48), where the last schwa is flanked by consonants with decreasing sonority.

(48)	MHG	NHG	
	seg[ə]l[ə]n	seg[ə]ln (*segl[ə]n)	'to sail'
	gest[ə]r[ə]n	gest[ə]rn (*gestr[ə]n)	'yesterday'
	zitt[ə]r[ə]n	zitt[ə]rn (*zittr[ə]n)	'to tremble'

Syncope typically leads to more complex consonant clusters thereby yielding violations of one of the two constraints in (49). Both constraints in (49) are supported by independent phonological evidence (cf. Vennemann 1988:).

(49) *COMPHEAD
Complex syllable heads are prohibited
*COMPCODA
Complex syllable codas are prohibited

As was noted in section 3 coda complexity is preferred to head complexity in German,[24] which indicates the ranking in (50). The fact that seg[ə]ln is preferred to seg[ə]l[ə]n indicates furthermore that *COMPCODA is dominated by $(\sigma^2)_F$.

(50)	Input			*COMPHEAD	*COMPCODA
	se.g[ə].l[ə]n		se.gl[ə]n	*!	
		→	se.g[ə]ln		*

Putative counterexamples as in (51) do not show that the ranking between *COMPHEAD and *COMPCODA can also be reversed, but indicate rather that both constraints are dominated by SON.

(51)	seg[ə]l[ə]r	Se.gl[ə]r (se.g[ə]lr)	'sailor'
	ad[ə]l[ə]r	a.dl[ə]r (*a.d[ə]lr)	'eagle'
	red[ə]n[ə]r	re.dn[ə]r (*re.d[ə]nr)	'speaker'
	schuld[ə]n[ə]r	Schul.dn[ə]r (*schul.d[ə]nr)	'debtor'

The data in (51) show furthermore that not only *COMPCODA but also *COMPHEAD is dominated by $(\sigma^2)_F$. The rankings between the relevant constraints is shown in (52):

(52)	Input			SON	$(\sigma^2)_F$	*COMPHEAD	*COMPCODA
a.			se.g[ə].l[ə]r		*!		
	seg[ə]l[ə]r		se.g[ə]lr	*!			
		→	se.gl[ə]r			*	
b.			se.g[ə].l[ə]n		*!		
	seg[ə]l[ə]n	→	se.g[ə]ln				*
			se.gl[ə]n			*!	

The description in (52) raises the question of how to eliminate the candidates with heterosyllabic clusters, which violate none of the constraints above (e.g. *seg.l[ə]n, *seg.l[ə]r). One possible approach is to rank the constraint HEADMAX defined in (53) above *COMPHEAD:

(53) HEADMAX
Prevocalic consonants must be syllabified in head position

Dominated by SON the constraint HEADMAX expresses the Maximum Onset Principle.[25]

[24] German differs hence from English where comparable cases of syncope gave rise to complex heads:

Engl. hun.d[ə].r[ə]d > hun.dr[ə]d
Engl. chil.d[ə].r[ə]n > chil.dr[ə]n

(54)	Input			SON	HEAD MAX	*COMP HEAD
a.	a.d[ə].l[ə]r		ad.l[ə]r		*!	
		→	a.dl[ə]r			*

While there is little controversy that words like Segler have indeed a complex head cluster (i.e. Se.[gl]er), the question of whether the remaining words have a complex head is far less clear. What is at issue here is the question of whether HEADMAX is dominated by the LOI stated in (55):

(55) LOI
Syllable heads must be a subset of the occurring word-initial heads

The evidence from Final Devoicing indicates that the LOI does not dominate HEADMAX in standard German.[26] That is, all obstruents in (51) remain voiced in Standard German after syncope has applied, regardless of the following sonorant (cf. Drosdowski, Giegerich). This indicates their syllabification in head rather than coda position. Violations of HEADMAX as in (56a) typically involve consonant-initial suffixes or consonant-final prefixes in support of the claim that those affixes do not form a single domain of syllabification together with the stem (cf. section 2.2.).

(56)a. Zeug.nis (Zeu[k]+nis) — b. Zeu.gma (Zeu[g]ma)
Ab.laß (A[p]+laß) — O.blate (O[b]late)

Assuming the correctness of the generalizations in 2.2. the HEADMAX violations in (56a) are explained by the prosodic structures in (57a):

(57)a. $(\text{Zeug})_\omega(\text{nis})_\omega$ — b. $(\text{Zeugma})_\omega$
$(\text{Ab})_\omega(\text{laß})_\omega$ — $(\text{Oblate})_\omega$

Reference to HEADMAX rather than the Law of Initials (henceforth LOI) in (54) may seem to be at odds with the fact that schwa loss in the word-initial syllable in (58) applied

[25] The ranking Head Max > Comp Head is also supported by loanword phonology (cf. the nonapplication of Syllable Final Devoicing in Sti[g]ma as opposed to Ba[k]dad)

(i)	Input			SON	HEAD MAX	*COMP HEAD
a.	stigma	→	sti[.g]ma			*
			sti[k.]ma		*!	
a.	bagdad		ba[.g]dad	*!		
		→	ba[k.]dad		*	

[26] Cf. Giegerich 1987

only if the resulting cluster satisfied the LOI.[27] That is, while word-initial clusters like gr, br, gl, bl, and gn existed prior to schwa loss in German, there were no words with initial gm, bm, gv, bn, etc.:

(58)a.	MHG	NHG		b.	MHG	NHG	
	g[ə]róp	grob	'coarse'		g[ə]mách	g[ə]mách	'slowly'
	b[ə]rílle	Brille	'glasses'		g[ə]méin	g[ə]méin	'mean'
	g[ə]lít	Glied	'limb'		g[ə]máhel	G[ə]máhl	'husband'
	g[ə]lükke	Glück	'luck'		b[ə]mérken	b[ə]mérken	'to remark'
	g[ə]lí:ch	gleich	'like'		b[ə]mánnen	b[ə]mánnen	'to man'
	g[ə]lóuben	glauben	'to believe'		b[ə]nîden	b[ə]néiden	'to envy'
	b[ə]lí:ben	bleiben	'to stay'		b[ə]nénnen	b[ə]nénnen	'to name'
	g[ə]náde	Gnade	'mercy'		g[ə]wínnen	g[ə]wínnen	'to win'

The stability patterns in (58) accordingly support the relevance of the LOI and indicate the following constraint ranking:

(59)	Input			LOI	*SCHWA	COMPHEAD
a.	g[ə]náde		g[ə]náde		*!	
		→	gnáde			*
b.	b[ə]néiden	→	b[ə]néiden		*	
			bnéiden	*!		

Assuming that the description in (59) is adequate, what accounts for the LOI-violations observed in (51)? Significantly, schwa loss results in LOI-violations only in originally dactylic forms. The crucial difference between words like MHG [bə.n]îden and MHG huo[bə.n]er, both of which include the string [bə.n], lies accordingly in their foot structure.

[27] Schwa is in general less likely to delete between an obstruent and a nasal than between an obstruent and a liquid. Some words in which schwa failed to delete between g and n are given in (i):

	MHG	NHG	
(i)	g[ə]nësen	g[ə]nesen	'to recuperate'
	g[ə]nicke	G[ə]nick	'neck'
	g[ə]nou	g[ə]nau	'exact'
	g[ə]nôse	G[ə]nosse	'comrade'
	g[ə]nuoc	g[ə]nug	'enough'
	g[ə]næme	g[ə]nehm	'suitable'

The fact that schwa tends to be stable between an obstruent and a nasal suggests that some complex heads are worse than others. That is, schwa stability between an obstruent and a nasal, but not between an obstruent and a liquid, may reflect a preference for a maximally sharp sonority increase in syllable heads (cf. Vennemann 1988:13ff). Such a preference is also manifested in the fact that obstruents delete before nasals (e.g. [gn]at > [n]at, [kn]ee > [n]ee) but not before liquids (e.g. [kr]y, [gl]ue) in Middle English (cf. Vennemann 1988:19) and calls for splitting *COMPLEX HEAD into several constraints which differ w.r.t. the sonority increase.

The apparent paradox can thus be resolved by ranking $(\sigma^2)_F$ above LOI but below HEADMAX:[28]

(60)	Input			SON	HEAD MAX	$(\sigma^2)_F$	LOI	*SCHWA	COMP HEAD
a.	b[ə].nî.den	→	b[ə].nî.den					*	
			bnî.den				*!		
b.			huo.b[ə].ner			*!			
	huo.b[ə].ner	→	huo.bner				*		
			huo[p].ner		*!				

The constraint ranking in (60) also explains the relevance of the LOI in the suffixed verbs in (19) and (20) discussed in section 3. That is, the suffix -ieren differs from the suffix -er in that it has initial stress and hence does not yield violations of the constraint $(\sigma^2)_F$.

(61)			SON	HEAD MAX	$(\sigma^2)_F$	LOI	*SCHWA	COMP HEAD
	→	nù.mm[ə]ríer[ə]n					*	
		nùmm.ríer[ə]n		*!				
		nù.mmríer[ə]n				*!		
		fîl.t[ə]ríer[ə]n		*			*	
	→	fîl.tríer[ə]n		*				
		fîlt.ríer[ə]n		**!				

Consider finally the ranking of COMPCODA. Since we know independently that *COMPHEAD dominates *COMPCODA it follows that schwa will delete in trochaic words even when yielding complex clusters. Examples are given in (62):

(62)	MHG	NHG	
	ern[ə]st	ernst	'serious'
	sanft[ə]	sanft	'gentle'
	sam[ə]t	samt	'along with'
	sim[ə]ʒ	Sims	'window sill'
	han[ə]f	Hanf	'hemp'

[28] While I consider the analysis in (60) to be basically correct it should be admitted that it rests more on my intuition than on facts. The problem is simply that there are almost no relevant examples to substantiate it. Specifically almost all cases of schwa loss in (58) involve the prefixes be- and ge-. The claim that schwa would fail to delete in words like d[ə].lX, d[ə].nX (as opposed to ád[ə].ler > á.dler, réd[ə].ner > ré.dner) can therefore not be tested. The paucity of relevant examples is made worse by the fact that schwa in those prefixes often fails to delete if the prefix combines with an independent word (e.g. b[ə]+laden (cf. laden 'to load'), b[ə]+rüeren (cf. rüeren 'to move')). This is presumably because stem boundaries align with prosodic word boundaries in these words (i.e. be+(laden)$_{\omega}$) and schwa deletion applies only within pwords (e.g. be+(laden)$_{\omega}$ vs (b[ə]lîben)$_{\omega}$). As a result schwa stability in b[ə]nîden could also be due the prosodic structure b[ə](nîden)$_{\omega}$ (cf. nîden 'to hate, to envy').

kel[ə]ch	Kelch	'goblet'
pferr[ə]ch	Pferch	'pen'
mön[ə]ch	Mönch	'monk'

Schwa loss in (62) is described in (63):

(63)	Input			*SCHWA	*COMPCODA
a.	er.n[ə]st		er.n[ə]st	*!	
		→	ernst		

While schwa loss has preserved word-initial phonotactic constraints it has given rise to many new word-final clusters. Indeed none of the clusters in (62) existed prior to MHG schwa loss in German. However, it is unclear whether this asymmetry is theoretically significant or whether it merely reflects the more limited distribution of schwa in wordinitial syllables.[29]

4.5. The SHELL stability effect

Consider the conditions of schwa loss in the near minimal pairs in (64a,b):

(64)a.	grüb[ə]l[ə]r	Grübl[ə]r	'brooder'	b.	zoub[ə]r[ə]r	Zaub[ə]r[ə]r	'magician'
	sam[ə]l[ə]r	Samml[ə]r	'collector'		kam[ə]r[ə]r	Kämm[ə]r[ə]r	'chamberlain'
	wand[ə]l[ə]r	Wandl[ə]r	'changer'		wand[ə]r[ə]r	Wand[ə]r[ə]r	'hiker'

Schwa loss in (64a) has already been described in tableau. The crucial difference between the words in (64) is presumably the flanking of the last schwa by two identical consonants in (64b), but not in (64a). However, reference to a constraint against syllables in which the nucleus is flanked by identical consonants obviously fails to distinguish between wellformed dactylic words like zoub[ə]r[ə]r, kam[ə]r[ə]r and the corresponding illformed trochaic forms zoubr[ə]r and kamr[ə]r. This problem is solved by the definition in (65), which is based on Vennemann's observation that identical speech sounds flanking the nucleus are especially disfavored when the syllable shell includes additional speech sounds (1988:11f).[30]

(65) SHELL
A syllable with the form CC_iNC_i is prohibited.

Schwa stability in (64) is described by ranking the constraint SHELL above $(\sigma^2)_F$, but below HEADMAX:

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[29] Recall that schwa by and large only occurred in the prefixes <u>be</u>- and <u>ge</u>-.

[30] One of the few German words which violates the constraint SHELL is fror, the past tense form of frieren 'to freeze'.

(66)	Input			SON	HEAD MAX	SHELL	$(\sigma^2)_F$
a.	wan.d[ə].l[ə]r		wan.d[ə].l[ə]r		*[31]		*!
		→	wan.dl[ə]r		*		
			wan[t].l[ə]r		**!		
a.	wan.d[ə].r[ə]r	→	wan.d[ə].r[ə]r		*		*
			wan.dr[ə]r		*	*!	
			wan[t].r[ə]r		**!		

Reference to HEADMAX rather than the LOI is hence based on two independent observations. First, the syllabification of all prevocalic consonants in head position (for as long as SON is satisfied) accounts for the preservation of voicedness in obstruent-sonorant clusters which do not occur word-initially (e.g. adeler > A[dl]er, redener > Re[dn]er, huobener > Hü[bn]er). Second, reference to HEADMAX accounts for the SHELL stability effect. If HEADMAX were dominated by LOI the stability of both schwas would be accounted for only in (67a), but not in (67b).

(67)	MHG	NHG	
a.	zoub[ə]r[ə]r (*zou.[brər]	Zaubə]r[ə]r	'magician'
b.	kam[ə]r[ə]r (*ka.[mrər]	Kämm[ə]r[ə]r	'chamberlain'
	wuoch[ə]r[ə]r (*wuo.[xrər]	Wuch[ə]r[ə]r	'profiteer'
	beʒʒ[ə]r[ə]r (*be.[srər]	(Ver)Bess[ə]r[ə]r	'improver'

The context-sensitivity of schwa loss exhibited in (64) can accordingly be cited in support of a principle of head-maximization in German, to be constrained only by SON. That is, even clusters of sonorants are allowed in head position as is shown by the description of the near-minimal pair Sammler, Kämmerer in (68):

(68)	Input			SON	HEAD MAX	SHELL	$(\sigma^2)_F$
a.	sa.m[ə].l[ə]r		sa.m[ə].l[ə]r				*!
			sam.l[ə]r		*!		
		→	sa.ml[ə]r				
a.	kä.m[ə].r[ə]r	→	kä.m[ə].r[ə]r				*
			käm.r[ə]r		*!		
			kä.mr[ə]r			*!	

While syllabifications like Sa.mler may strike some readers as odd very similar conclusions have been drawn by Hooper (1976) based on her study of schwa loss in American English.

[31] Candidates which incur no HEADMAX violations are ruled out by SON (e.g. wa.nderer).

Consider the patterns of schwa loss in (69a,b) (cf. Zwicky). Schwa loss applies only in dactyls (e.g. sé[pər]ate > sé[pr]ate, but sé[pər]ate) and is sensitive to word frequency (e.g. sé[pər]ate > sé[pr]ate, but obstré[pər]ous (*obstré[pr]ous)):

(69)a.	sé[pər]ate > sé[pr]ate	c.	thé[rəp]y *> thé[rp]y
	lí[bər]al > lí[br]al		sy[ləb]le *> sy[lb]le
	bró[kəl]i > bró[kl]i		aspá[rəg]us *> aspá[rg]us
	chán[səl]or > chán[sl]or		é[ləf]ant *> é[lf]ant
b.	bé[vər]age > bé[vr]age		cy[nək]al *> cy[nk]al
	cá[θəl]ic > cá[θl]ic		compá[rəs]on *> compá[rs]on
	fá[məl]y > fá[ml]y		é[ləg]ant *> é[lg]ant
	cá[mər]a > cá[mr]a		ó[rəj]in ó[rj]in
	gé[nər]al > gé[nr]al		é[ləm]ent *> é[lm]ent
	tó[lər]ant > tó[lr]ant		có[lən]y *> có[ln]y

As was noted by Hooper the stability of schwa is determined by the relative sonority between the flanking consonants. If sonority rises schwa tends to disappear (cf.69 a,b). If sonority falls schwa is stable (cf.69c). Hooper interprets this generalization in support of a principle of Head Maximization constrained not by the language-specific LOI, but only by a universal constraint which requires sonority to rise in syllable heads. Indeed, unless one were to claim that schwa loss applies when yielding a bad syllable contact but not when yielding a good syllable contact Hooper's conclusion that the syllable boundaries in (69a,b) always precede the bracketed clusters regardless of the quality or quantity of the preceding vowel has to be accepted. Even clusters of liquids are tolerated for as long as SON is satisfied. Hooper's insight could be expressed in terms of the following ranked constraints:[32]

(70)	Input			SON	HEAD MAX	$(\sigma^2)_F$
a.			tó.l[ə].rant			*!
	tól[ə]rant		tól.rant		*!	
		→	tó.lrant			
a.		→	the.r[ə].py			*
	thér[ə]py		ther.py		*!	
			the.rpy	*!		

The types of context-sensitivity exhibited by schwa loss in dactyls indicates accordingly that word-internal syllabification in both languages is determined by universal sonority constraints (e.g. German Sa.[ml]er, English to.[lr]ant), rather than the language-specific LOI.

[32] Assuming that both schwas are stable in words like murderer one would have to assume that SHELL dominates $(\sigma^2)_F$ also in American English.

While supporting the principle of head maximization the English data also indicate an inviolable constraint on head complexity. That is, syllable heads must consist of maximally two segments. This constraint, which dominates HEADMAX and will be referred to as HEADBIN (headbinarity), accounts for the stability of schwa in cutlery (cf. (71)). The high ranking of HEADBIN in English is also shown by constraints on historical glide insertion before [u:]: the glide is not inserted if two consonants precede (e.g. [lu:]cid > [lju:]cid, but no insertion in [klu:] 'clue'). This is because the syllable head would otherwise include three segments (e.g. *[klju:]).

(71)	Input			SON	HEAD BIN	HEAD MAX	$(\sigma^2)_F$
a.			cú.tlry		*		
	cútl[ə]ry		cút.lry			*	
		→	cú.tl[ə].ry				*

HEADBIN, as is shown by schwa loss in words like boist[ə]rous, mast[ə]ry. Syllable-initial s also does not count with respect to the process of English Glide Insertion (e.g. [stu:] 'stew' > [stju:]). Syllable-initial s differs from other segments in the syllable head in that it is not subject to SON. Both SON and HEADBIN must accordingly be interpreted as referring to the 'core head' , that is, the head without initial s. There is evidence to be reviewed below that HEADBIN is inviolable in German as well.

Returning to the SHELL Stability Effect in German note that the ranking in (68) accounts for stable dactyls only if both schwas are necessary to prevent a complex syllable head. In other cases trochaic forms will be optimal as is illustrated in (72):

(72)			SON	HEAD MAX	SHELL	$(\sigma^2)_F$
a.		mau.[ə].r[ə]r				*!
	→	mau.r[ə]r				
		ma.ur[ə]r	*!			

The schwa pattern in (72) is difficult to describe in terms of the epenthesis rule in (11), which has been proposed within Lexical Phonology. Recall that epenthesis is sensitive to the sonority structure within a given morphological domain, but cannot look ahead to the suffixes to be attached later. The inadequacy of such an approach can be illustrated with agentive nouns like Kämmerer versus Maurer, which would be derived from the "unsyllabifiable stems" kämmr and maur. The epenthesis rule in (11) would apply in both cases with the result that Maurer cannot be generated. The correct form can be selected only if fully derived words are evaluated as is shown in (72). The crucial difference between Kämmerer and Maurer is that the cluster [mr] is a wellformed syllable head whereas [ur] is not.

In contrast to SON, the constraint SHELL is violable under two conditions. The first case is illustrated with the inflected adjectives in (73):

(73)a.		b.	
	maka**br[ə]r** 'macabre'		sau**b[ə]r[ə]r** 'clean'
	inte**gr[ə]r** 'having integrity'		ha**g[ə]r[ə]r** 'haggard'
	illu**str[ə]r** 'illustrious'		dü**st[ə]r[ə]r** 'gloomy'
	sini**str[ə]r** 'sinister'		fin**st[ə]r[ə]r** 'dark'

According to Drosdowski (ed.) 1984:290, the pattern in (73a) (i.e. the SHELL violations) is characteristic of nonnative adjectives. The fact that loans such as clever from English and koscher from Yiddish, both of which violate native phonotactic patterns[33], follow the pattern in (32b) (i.e. clev[ə]r[ə]r, kosch[ə]r[ə]r) casts doubt on that explanation. An alternative account refers to overall word length. Assuming that SHELL is dominated by a constraint "$(\sigma^3)_\omega$", which restricts the number of syllables in prosodic words to maximally three syllables, the data in (73) are explained:

(74)			SON	HEAD MAX	$(\sigma^3)_\omega$	SHELL	$(\sigma^2)_F$
a.		ma.ká.b[ə].r[ə]r			*!		
		ma.káb.r[ə]r		*!			
	→	ma.ká.br[ə]r				*	
b.		saub.r[ə]r		*!			
		sau.br[ə]r				!*	
	→	sau.b[ə].r[ə]r					*

The existence of prosodic words with four or more syllables (e.g. Tohuwabohu 'chaos' Parallelogramm 'parallelogram'), which may even include schwa (e.g. Fisimatent[ə]n 'excuses, fuss', Hämorrhoid[ə]n 'haemorrhoids'), shows that the constraint $(\sigma^3)_\omega$ is dominated by constraints like SON and PRESERVE PLACE.

The other case in which SHELL violations occur are verbs, which shows that the ranking of constraints can depend on the syntactic category of words.[34] In table (75) inflected adjectives are compared with infinitives:

(75)a.		b.	
	inflected adjectives (acc. sg. masc.):		verbs:
	trock[ə]n[ə]n 'dry'		trockn[ə]n 'to dry'
	eb[ə]n[ə]n 'flat'		ebn[ə]n 'to flatten'
	eig[ə]n[ə]n 'own'		eign[ə]n 'to be suited'
	off[ə]n[ə]n 'open'		öffn[ə]n 'to open'

[33] The adjective clever does not conform to German phonotactics in that voiced fricatives are never preceded by lax vowels in native words (cf. Löwe 'lion', Wiese 'meadow'). The adjective koscher is marked in that the fricative [s] is preceded by a tense vowel. This pattern does not occur in native words with the exception of wusch, which is the past tense form of waschen 'to wash'.

[34] The claim that phonological wellformedness conditions are category-specific is also supported by English stress patterns. In fact, even phonotactics may be sensitive to the syntactic category of words as is shown by the distribution of voiced versus voiceless interdental fricatives in English.

Historically, verbs had the same prosodic forms as the adjectives in (75a). A possible interpretation of the difference in (75) is that in verbs the order between SHELL and "$(\sigma^2)_F$" reversed in NHG.

4.6 A note on sonority

Assuming that the account of syllabification in (74) is basically correct the evidence from schwa loss also sheds light on the sonority hierarchy. For example, the stability of both schwas in Kämmerer indicates that r is more sonorous than m in accordance with the tentative hierarchy in (15). Consider now the only phonologically conditioned rule of schwa epenthesis in the transition from MHG to NHG, which coincided with the diphthongization of long high vowels:

(76)	fi:r > faɪ[ə]r	'celebration'
	fy:r > fËɪ[ə]r	'fire'
	mu:r > mau[ə]r	'wall'

While all long high vowels became diphthongs consisting of a low nucleus followed by a high glide, epenthesis applied only before r (e.g. fu:l > faul, not *fau[ə]l, fi:n > fain, not *fai[ə]n). This particular restriction indicates that the conditions on schwa insertion in (76) relate to sonority. This is because high vowels, being the least sonorous vowels, are adjacent to r, which is the most sonorous consonant, as is shown in the more detailed sonority hierarchy of sonorants shown in (77):

(77) increasing sonority decreasing sonority

<--->

low vowels	mid vowels	high vowels	r	l	nasals

Assuming that glides are high vowels syllabified in non-peak position and that individual languages allow for the merger of adjacent sonority classes epenthesis in (76) can be described by revising the sonority hierarchy as follows:

(78) increasing sonority decreasing sonority

<--->

low vowels	mid vowels	high vowels	glides r	l	nasals

Ignoring the constraints describing diphthongization historical schwa insertion in (76) is described simply by the ranking in (79). This is because according to the hierarchy in (79) sonority fails to decrease in the coda [ur].

(79)	Input			SON	SCHWA
a.	mu:r		maur	*!	
			mau[ə]r		*

Consider next the evidence for sonority distinctions between nasals. Recall the analysis of schwa deletion in American English in terms of the constraint ranking in (71). The additional data in (80) show that schwa disappears between m and n, but not if the order of the nasals is reversed:

(80)a.	fé[mən]ine > fé[mn]ine	b.	é[nəm]y (*é[nm]y)
	dó[mən]ant > dó[mn]ant		ecó[nəm]y (*ecó[nm]y)
	nó[mən]al > nó[mn]al		cí[nəm]on (*cí[nm]on)
	Gér[mən]y > Gér[mn]y		Pá[nəm]a (*Pá[nm]a)
	stá[mən]a > stá[mn]a		a[nəm]al (*a[nm]al)

To account for the data in (80) Hooper assumes that n is more sonorous than m. Assuming that schwa loss in (80a) is indeed determined by the relative sonority between the consonants which flank the schwa it follows that the sonority hierarchy needs to be refined as in (81):

(81) increasing sonority decreasing sonority

<-- -------------------

vowels low ---------high	r	l	n	m	fricatives	stops, affricates

Independent evidence in support of this assumption comes from phonotactic restrictions in Greek and Irish. Both languages allow the word-initial cluster mn, but not nm. Assuming that the occurrences of the two consecutive schwa syllables in the inflected adjectives in (75a) are also manifestations of the SHELL Stability Effect the German data can also be cited in support of the hierarchy in (81).[35] This is because the effect exists in the adjective vollkomm[ə]n[ə]n 'complete', which has the prosodic structure (voll)$_{\omega}$(kommenen)$_{\omega}$.

If the correlations observed here held universally this would argue for a more finely grained universal sonority hierarchy where sounds are further classified in terms of distinct places of articulation. Individual languages would on this view allow for the merger of adjacent slots such that the relative ranking between the merged sound classes and other classes within the hierarchy are retained.

4.7 Glide Formation

In view of the significance of the (controversial) principle of head maximization (rather than

[35] The claim that the inflected adjectives in (75a) exhibit the SHELL stability effect is supported by the fact that dactyls occur only in those paradigms which include at least one member which violates SHELL(e.g. tróckenen, óffenen, múnterer, wáckerer, but not férnen, ármem, or any adjective whose stem-final consonant is not identical to one of the four suffixes (i.e. n, m, r, s), such as inflected forms of dunkel, übel, etc)

the LOI) for the account of schwa stability I will discuss additional evidence in support of that principle. Consider the rule of optional Glide Formation in Standard German (cf Drosdowski 1990), which (contrary to the description in Hall 1992) applies only in dactyls and thus differs from obligatory Glide formation in non-initial prestress position (e.g. Relig[j]ón (*Religion)) and from for many speakers unacceptable glide formation in the word-initial syllable (e.g. ??P[j]áno). Glide Formation in German differs from schwa loss in American English in that it is insensitive to word frequency:

(82)a.	Óp[j]um 'Opium'	b.	Mor[f][j]um 'Morphium'	c.	Hafn[i]um 'Hafnium'
	Kál[j]um 'Kalium'		Kal[t^s][j]um 'Kalzium'		Natr[i]um 'Natrium'
	Gall[j]um 'Gallium'		Olymp[j]a 'Olympia'		Osm[i]um 'Osmium'
	Itál[j]en 'Italien'		Órg[j]e 'Orgie'		Omn[i]um 'Omnium'
	Tragöd[j]e 'Tragödie'		Líl[j]e 'Lilie'		Hydr[i]a 'Hydria'
	Millén[j]um 'Millenium'		Kamb[j]um 'Kambium'		Re[kv][i]en 'Requien'

Glide formation always applies if one consonant precedes (cf. (82a)). If two consonants precede Glide Formation applies only if the sonority decreases according to the hierarchy in (81), but not if sonority increases. These facts suggest that both consonants preceding the i in (82c) are syllabified in head position, regardless of language-specific LOI-restrictions. Glide Formation is accordingly described by the ranking in (83), which is identical to the ranking describing schwa loss in American English. The fact that Glide Formation does not apply in words like Omnium, where i is preceded by the cluster [mn], supports the claim that n is more sonorous than m.

(83)	Input			SON	HEAD BIN	HEAD MAX	$(\sigma^2)_F$	*COMP HEAD
a.			Mó.r[fi]um	*!				
	Mór[fi]um		Mór.[fi]um			*	*!	
			Mór.[fj]um			*		
			Há.fn[i]um					
	Háfn[i]um		Há.fn[j]um		*!			
			Háf.n[j]um			*!		
			Há.fn[i].um				*	

The fact that glide formation applied in words like Bestie, Hostie shows that the syllable-initial coronal fricative does not count regarding the constraint on the "core head" to maximally two positions. The fact that glide formation applied in words like Kalzium, Razzia, Aktie supports the claim that affricates are monosegmental in German.

5. Identity effects in adjectival paradigms

In this section I introduce a constraint, LEVEL, which explains the occurrence of certain phonologically unmotivated schwas in terms of a condition of paradigm leveling.

As was noted in section 3, on the basis of purely phonological criteria the forms of the inflected adjectives listed in ($84A_{lock}$) are preferable to the actual forms listed in ($84B_{lock}$). This is because paradigm A_{lock} has fewer violations of the constraint $(\sigma^2)_F$.

(84)	A_{lock}	B_{lock}	C_{lock}	D_{lock}
	lock[ə]r[ə]r	lock[ə]r[ə]r	lock[ə]rr	lockr[ə]r
	lock[ə]rs	lock[ə]r[ə]s	lock[ə]rs	lockr[ə]s
	lock[ə]rn	lock[ə]r[ə]n	lock[ə]rn	lockr[ə]n
	lock[ə]rm	lock[ə]r[ə]m	lock[ə]rm	lockr[ə]m
	lock[ə]r	lock[ə]r[ə]	lock[ə]r	lockr[ə]

In paradigm A_{lock} all schwas are phonologically motivated: they are needed to satisfy the constraints SON and SHELL. The reason for preferring paradigm B_{lock} to paradigm A_{lock} lies in the fact that B_{lock} is more leveled. Being 'more leveled' means that the members of a paradigm bear a greater phonological similarity to each other. Specifically, the members of paradigm B_{lock} all have the same number of syllables which is not true for the members of paradigm A_{lock}. Assuming that there is a constraint LEVEL which requires all members of the paradigm to have the same number of syllables the preference of paradigm B_{lock} over paradigm A_{lock} is explained as follows. Recall that the ranking between SON, SHELL, and $(\sigma^2)_F$ has been established in section 4. While satisfying LEVEL to the same extent as the winning paradigm B_{lock}, candidates C_{lock} and D_{lock} are both fatally flawed. Paradigm C_{lock} is eliminated because it includes the SON-violator <u>lock[ə]rr</u>. Paradigm D_{lock} is eliminated because it includes a member which violates SHELL, e.g. <u>lockr[ə]r</u>.

(85)			SON	LEVEL	SHELL	$(\sigma^2)_F$
		A_{lock}		*!		
	→	B_{lock}				****
		C_{lock}	*!			
		D_{lock}			*!	

The observation that the existence of one potential SHELL-violator among the members of an adjectival paradigm (e.g. the form <u>lock</u>[ə]<u>r</u>[ə]<u>r</u>) implies that *all* members end in two schwa-syllables strongly supports the analysis in (85). That is, the constraint ranking in (85) solves the "sonority puzzle" first presented in (21). The three adjectives contrasted there are those which are framed in (86):

(86)	loc**k[ə]r[ə]r**	trock[ə]n[ə]r	dunkl[ə]r
	lock[ə]r[ə]s	trock[ə]n[ə]s	dunkl[ə]s
	lock[ə]r[ə]n	troc**k[ə]n[ə]n**	dunkl[ə]n
	lock[ə]r[ə]m	trock[ə]n[ə]m	dunkl[ə]m
	lock[ə]r[ə]	trock[ə]n[ə]	dunkl[ə]

Looking at the three framed adjectives in isolation, the distribution of schwa is mysterious indeed. However, once we look at the respective paradigms as a whole the patterns are explained. Because the inventory of inflectional adjectival suffixes include nasals and r the paradigms of adjectives in which a 'stem-final' nasal or r follows a less sonorous consonant regularly include at least one member which potentially violates SHELL and therefore ends in two schwa syllables (cf. the words with the boldfaced segments in (86)).[36] The high ranking of LEVEL w.r.t. $(\sigma^2)_F$ implies that all members of the respective paradigms end in two schwa syllables. By contrast, paradigms of adjectives with a 'stem-final' l (e.g. dunkel 'dark' übel 'evil' etc.) never include a potential SHELL violator because the inventory of adjectival inflectional suffixes does not include l. Consequently, the inflected forms of such adjectives always end in a single schwa syllable.

To summarize, on the analysis in (85) all dactylic forms in (86) other than those including bold-faced segments are analysed as identity effects. A prerequisite of such an analysis is that the candidates to be evaluated in (85) consist of complete paradigms rather than individual words. Empirically, the analysis embodies a claim that the basis for leveling in inflectional paradigms is not necessarily the most frequent or least marked form. Rather, the basis for leveling is determined by constraint ranking. That is, lock[ə]r[ə]r in A_{lock} is not leveled to adjust to the phonologically optimal trochaic forms in that paradigm. Rather, all forms are leveled on the basis of lock[ə]r[ə]r, because SHELL dominates $(\sigma^2)_F$.

While not motivating the existence of phonologically unwarranted schwas, the constraint LEVEL is crucial for explaining the distribution of schwas in the paradigm of dunkel. Specifically, the fact that in most members of that paradigm the schwa appears in the

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[36] Recall that there exists one class of adjectives which does not end in two schwa syllables even if matching the sonority structure in question, that is, the polysyllabic adjectives like makaber, integer, etc. discussed in section 2.2. The fact that the derived forms of those adjectives fail to satisfy SHELL (e.g. makabrer, integrer) has been taken to indicate that SHELL is dominated by a constraint "$(\sigma^3)_\omega$" which limits the number of syllables in prosodic words. The ranking "$(\sigma^3)_\omega$ >> SHELL, LEVEL >> *SCHWA" leads us to expect that the optimal inflectional paradigms of those adjectives are leveled such that all forms end in a single schwa syllable. This is in fact correct as is illustrated in (i):

(i)	makabr[ə]r	integr[ə]r
	makabr[ə]s	integr[ə]s
	makabr[ə]n	integr[ə]n
	makabr[ə]m	integr[ə]m
	makabr[ə]	integr[ə]

Paradigms of adjectives where the 'stem-final' consonant follows a more or equally sonorous segment (e.g. fern 'far', or sau[ə]r 'sour') do not include a potential SHELL-violator regardlesss of the inflectional suffix added and therefore must not include any forms ending in two schwa syllables. In fact, they never do as the tableau in (62) describes correctly. The actual paradigms of fern and sauer are listed in (ii):

(ii)	fern[ə]r	saur[ə]r
	fern[ə]s	saur[ə]s
	fern[ə]n	saur[ə]n
	fern[ə]m	saur[ə]m
	fern[ə]	saur[ə]

phonologically disfavored site is due to LEVEL. Compare A_{dun}, the actual paradigm, with B_{dun}, the paradigm containing the phonologically optimal forms:

(87)	A_{dun}	B_{dun}	C_{dun}	D_{dun}
	dunkl[ə]r	dunkl[ə]r	dunk[ə]lr	dunk[ə]l[ə]r
	dunkl[ə]s	•dunk[ə]ls	•dunk[ə]ls	dunk[ə]l[ə]s
	dunkl[ə]n	•dunk[ə]ln	•dunk[ə]ln	dunk[ə]l[ə]n
	dunkl[ə]m	•dunk[ə]lm	•dunk[ə]lm	dunk[ə]l[ə]m
	dunkl[ə]	•dunk[ə]l	•dunk[ə]l	dunk[ə]l[ə]

All forms marked with a dot in (87) are phonologically superior to the corresponding forms in the actual paradigm in that the schwa breaks up the rightmost cluster in which sonority fails to decrease (e.g. kl) rather than follows that cluster (cf. sections 2, 3). The tableau in (88) shows why candidate A_{dun} is nonetheless optimal:

(88)			SON	LEVEL	SHELL	$(\sigma^2)_F$	COMP HEAD
	→	A_{dun}					*****
		B_{dun}		*!			
		C_{dun}	*!				
		D_{dun}				*****!	

Despite incurring fewer violations of COMPHEAD than the optimal paradim, both B_{dun} and C_{dun} are fatally flawed: B_{dun} is phonologically optimal, but not leveled whereas A_{dun} which is leveled, includes a SON-violator (e.g. dunk[ə]lr). This dilemma, as it involves LEVEL, is specific to paradigms, explaining the fact that in German all words with the schwa in the disfavored site (e.g. dunkl[ə]n rather than dunk[ə]ln) are members of paradigms (cf. section 2.). Candidate D_{dun} is eliminated because of gratuitious occurrences of $(\sigma^2)_F$-violations.

The analysis of the disfavored sites of the schwa in the winning paradigm in (88) also explains the 'celebrated minimal pair' in (25) which is repeated in (89):

(89) dunkl[ə]n]$_{AINFL}$ - Dunk[ə]ln]$_{NINFL}$

The reason for the distinct sites of the schwa in (89) becomes clear in view of the complete paradigms. Compare the adjectival paradigm candidates of dunkel in (90a) with the corresponding nominal paradigm candidates in (90b) (the respective actual paradigms are framed):[37]

[37] Following German orthography, the subscript in the name of the nominal paradigms is capitalized, thereby differing from the adjectival paradigms.

(90)a. adjectival:

A_{dun}	C_{dun}
dun**kl**[ə]r	dun**k**[ə]**l**r
dun**kl**[ə]s	dun**k**[ə]**l**s
dun**kl**[ə]n	dun**k**[ə]**l**n
dun**kl**[ə]m	dun**k**[ə]**l**m
dun**kl**[ə]	dun**k**[ə]**l**

b. nominal:

A_{Dun}	B_{Dun}
Dun**k**[ə]**l**	Dun**kl**[ə]
Dun**k**[ə]**l**s	Dun**kl**[ə]s
Dun**k**[ə]**l**n	Dun**kl**[ə]n

Crucially, adjectival and nominal paradigms differ with respect to their suffixes, in particular, regarding the question of sonority values. The inventory of adjectival inflectional suffixes includes the sonorant r, (which is more sonorous than the stem-final l in dunkel), whereas the most sonorous suffix in the nominal paradigm is the n (which is less sonorous than the stem-final l in Dunkel). As a result, leveling in the nominal paradigm is achieved at no phonological expense: each member in A_{Dun} would beat all corresponding forms in other paradigms if the words were evaluated individually. By contrast, as was discussed above, leveling in the adjectival paradigm can only be achieved at the expense of including the forms with the disfavored site of the schwa. The different sites of the schwa in (89) result accordingly from the fact that the constraint COMPHEAD plays a role in the evaluation of the nominal but not of the adjectival candidates as is shown in tableau (91):

(91)			SON	LEVEL	SHELL	$(\sigma^2)_F$	COMP HEAD
	→	A_{dun}					*****
		C_{dun}	*!				
		A_{Dun}					
		B_{Dun}					***!

The reason for 'celebrating' the pair in (89) in Lexical Phonology concerns the claim that the distribution of the schwa reveals the existence of distinct strata. Alternatively, it has been suggested that that distribution shows that adjectival inflectional suffixes are lexically associated with schwa whereas nominal suffixes are not (cf. the references on page 149).[38] In contrast to both of these approaches I have argued that the distribution of the schwa in (89) follows straightforwardly from the independent observations that (i) inflectional paradigms in German are leveled and (ii) the inventories of adjectival and nominal inflectional suffixes differ with respect to their sonority values. This analysis renders superfluous both the assumption of distinct strata and the stipulation that some suffixes are lexically associated with schwa whereas others are not.

[38] The fact that adjectival suffixes are also associated with schwa in the absence of potential sonority violations (e.g. the paradigm of roh 'raw': roh[ə]r, roh[ə]n, roh[ə]s, etc.) is part of a wider generalization according to which all sonorant suffixes regardless of their category are associated with schwa. This generalization is discussed in section 2.5.1.

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Prosodic constituents in the representation of consonantal sequences in Polish

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1 Introduction

The aim of this paper is to show what role prosodic constituents, especially the foot and the prosodic word play in Polish phonology. The focus is placed on their function in the representation of extrasyllabic consonants in word-initial, word-medial, and word-final positions.

The paper is organized as follows. In the first section, I show that the foot and the prosodic word are well-motivated prosodic constituents in Polish prosody. In the second part, I discuss consonant clusters in Polish focussing on segments that are not parsed into a syllable due to violations of the Sonority Sequencing Generalisation, i.e. extrasyllabic segments. Finally, I analyze possible representations of the extrasyllabic consonants and conclude that both the foot and the prosodic word play a crucial role in terms of licensing. My proposal differs from the ones by Rubach and Booij (1990b) and Rubach (1997) in that I argue that the word-initial sonorants traditonally called extrasyllabic are licenced by the foot and not by the prosodic word (cf. Rubach and Booij (1990b)) or the syllable (cf. Rubach (1997)). For my analysis I adopt the framework of Optimality Theory, cf. McCarthy and Prince (1993), Prince and Smolensky (1993), in which derivational levels are abandoned and only surface representations are evaluated by means of universal constraints.

1.1 Stress assignment

In comparison with other Slavic languages Polish has predictable stress[1] and the foot plays a crucial role in its assignment. Feet are maximally bisyllabic and left-headed. Primary stress falls on a penultimate syllable, while a secondary stress is assigned to an initial syllable.[2] Kraska-Szlenk (1995) also mentions tertiary stress which falls on every odd syllable – except for the initial one – starting from the left edge of the word, i.e. every foot head.

In (1) some examples illustrating stress assignment are shown. Feet are indicated by parentheses, '1' marks primary stress, '2' shows the placement of the secondary stress and '0' indicates no stress, a dot corresponds to a syllable boundary and '+' to a morpheme boundary.

* I would like to thank the audience at the DGfS annual meeting (March 2000, Marburg) for the discussion of some topics in the present paper. I am especially grateful to Tracy Alan Hall and Bożena Cetnarowska for their comments on the written version of the paper. Any errors are of my responsibility.

[1] Most Slavic languages, e.g., Belorussian, Bulgarian, Russian, and Ukrainian have a lexicalized stress system. For comparison of the prosodic systems of Slavic languages see Rochoń (in prep.).

[2] There are a few exceptions to this rule in foreign words and in stem+clitic structure, cf. discussion below, in which stress falls on the antepenulimate syllable.

(1) Stress assignment in Polish

a. grymas ‘grimace’ nom.sg.

1 0
(gry.mas)

b. grymaś+ny ‘fussy’ adj.masc.nom.sg.

0 1 0
gry.(ma.□ny)

c. grymaś+nic+a ‘fussy girl’ nom.sg.

2 0 1 0
(gry.ma) (śni.ca)

d. grymaś+nic+ami ‘fussy girl’ instr.pl.

2 0 0 1 0
(gry.ma.) □ni.(ca.mi)

The stress pattern presented in (1) leads to the conclusion that suffixes create with stems prosodic words. This is shown in (2). In the following the prosodic word will be abbreviated ‘ω’.

(2) $[$(gry.ma.) □ni.(ca.mi)$]_{\omega}$

As far as prepositions are concerned, they are generally not stressed. Consider examples in (3) showing that prepositions like *do* ‘to’, *przez* ‘through’ *przed* ‘in front of’ are not accented when they occur before nouns, cf. Dogil (1999:834).

(3) do domu ‘to home’

0 (1 0)

przez miasto ‘through the city’

0 (1 0)

przed teatrem ‘in front of a theatre’

0 0 (1 0)

The patterns in (3) suggest that prepositions are not incorporated into a prosodic word with the following stem, because they do not bear a secondary stress. This is shown in (4).

(4)

przed teatrem ‘in front of a theatre’

0 $[$0 (1 0)$]_{\omega}$

Interestingly, there are prepositions which behave in a different way, i.e., in some phrases they are stressed whereas in others they are not. Examples in (5) show expressions in which the primary stress falls on the preposition.

(5) Jadę na wieś. ‘I am going to the countryside.’
(1 0)

Wrócę na noc. ‘I will be late in the evening.’
(1 0)

we dnie ‘in the day’
(1 0)

ze mną ‘with me’
(1 0)

As mentioned above, the same prepositions used even with the same object but in a different semantic context are never stressed, as shown by the examples in (6), cf. Rubach and Booij (1985:315) and Dogil (1999: 870).

(6) Tatarzy napadli na wieś. ‘The Tatars raided the village.’
0 1

Na noc składa się okres od… ‘Night is composed of a period of…’
0 1

Rubach and Booij (1985:315) suggest that the phrases with the irregular stress pattern in (5) are to be regarded as lexicalized.[3] By contrast, the prepositions in (6) behave in a regular manner, cf. also examples in (3).

Other exceptions occur when the prepositions precede pronominal clitics. Consider examples shown in (7), cf. Dogil (1999:835). Especially important is the first example because it clearly shows a contrast with trisyllabic sequences presented in (3).

(7) a. *ode mnie* ‘from me’
$[0\ (1\ \ 0)]_{\omega}$

b. *dla mnie* ‘for me’
$[(1\ \ 0)]_{\omega}$

[3] This conclusion is additionally supported by the fact that the prepositions *w* ‘in’ and *z* ‘with’ show up in (5) as *we* / *ze* and are outputs of the rule of *Lower* discussed in 1.3.2.

One can argue in favor of the representation presented in (8). However, an important argument against it, is that a grammatical word (*ode*) would be split by a prosodic word boundary, see Hall (1999) for discussion.

(8) *ode mnie* ‘from me’

0 [(1 0)]$_{\omega}$

Another exception to the stress pattern in Polish is found in the behaviour of two enclitics such as *śmy* ‘1ps.pl.’ and *ście* ‘2ps.pl.’ If they occur with hosts, they are stressed in two different ways. Relevant examples are provided in (9).

(9) *przy.wie.źli+śmy*	‘to bring’ 1ps.pl.past	*odwiedzili+ście*	‘to visit’ 2ps.pl.past
a. (2 0) (1 0)		a. (2 0) 0 (1 0)	
b. 0 (1 0) 0		b. (2 0) (1 0) 0	

The stress pattern provided in (9)a fits into the Polish stress system because the main stress falls on the penultima. On the other hand, the stress falling on the antepenultima in (9)b is also found in the spoken language of Polish. It is occasionally used, especially by the older generation or by younger people if they were trained to use the irregular pattern.

Taking into consideration the distribution of stress as a diagnostic for determining prosodic words and assuming that the right edge of a foot coincides with a right edge of a prosodic word, a question arises as to how the structures in (9) should be adequately represented. One possibility is that hosts with clitics which are accented as in (9)a create one prosodic word. This is shown in (10), cf. e.g. Kraska-Szlenk (1995).

(10) (odwiedzili+ście)$_{\omega}$

The accentuation pattern in (9)b suggests that clitics are not incorporated into the prosodic word, cf. (11), cf. Kraska-Szlenk (1995).

(11) *(odwiedzili)*$_{\omega}$+*□cie*

The representations in (10) and (11) show that a prosodic word plays a crucial role in stress assignment and explains ‘irregular’ stress in an adequate way: when a suffix or clitic is incorporated into a prosodic word the stress falls on penultima as expected. In other cases when a suffix or clitic does not belong to a prosodic word, stress is assigned to the antepenultima.

1.2 Syllabification

In many languages syllabification is generally considered to be one of the most important diagnostics used for the determination of prosodic words, cf. Booij (1985), Nespor & Vogel (1986), Hall & Kleinhenz (1999). In the following, I test this diagnostic in Polish with respect to (i) prefixes, (ii) suffixes, and (iii) prepositions in order to analyze their prosodic representation and to show how it corresponds with other diagnostics, i.e., stress assignment and phonological rules.

One of the reasons for assuming that prefixes in Polish are independent prosodic words is that the final consonants of prefixes are not resyllabified into the onset of the initial stem syllable. Consider the examples in (12). It is important to note that in Polish *dr*- and *dń*- are legitime syllable onsets as in *droga* 'road' nom.sg. and *dnia* 'day' gen.sg.

(12) nad+rywać nad.rywać 'to strain' imper.inf.
pod+nieść pod.nieść 'to raise' perf.inf.

In other words, the syllabification in (12) suggests that prefixes are 'noncohering' in the sense that they do not belong to the prosodic words of the stem but create separate prosodic words. One could alternatively argue that prefixes like the ones in (12) are not dominated by their own prosodic words. Both representations are shown in (13a) and (13b), respectively.

(13) a. podnieść → $(\text{pod})_\omega(\text{nieść})_\omega$ 'to raise' perf.inf.
b. podnieść → pod $(\text{nieść})_\omega$ 'to raise' perf.inf.

Considering the data in (12) one can also conclude that the decisive role in the syllabification is played not by a *prosodic word* boundary but rather by a *morphological* boundary between a prefix and a stem (nad+rywać). This possibility is confirmed by the syllabifications of prefixes with vowel-initial stems, cf. examples in (14).

(14) pod+odcinek pod.odcinek *po.docinek 'subection' nom.sg.
pod+orać pod.orać *po.dorać 'to give a first ploughing' inf.

The examples presented in (14) show that even if a stem begins with a vowel, no resyllabification across word-boundaries takes place.[4] In terms of constraints one can also argue that the impossibility of resyllabification in (14) is caused by the left stem bracket blocking resyllabification, cf. Rubach and Booij (1990). In OT a constraint guaranteeing that the left edge of a stem and the left edge of a syllable align would be higher ranked than a constraint prohibiting syllables without onsets, cf. McCarthy and Prince (1993).

[4] It is interesting to notice that Szpyra (1989) maintains that final consonants of prefixes like those in (12) can be resyllabified. For example, words like *pod+oficer* 'non-commissioned officer' and *nad+użyć* 'to abuse' may be syllabified not only as *pod.oficer* and *nad.użyć* but also as *po.doficer* and *na.dużyć*, respectively, cf. Szpyra (1989:203). However as she admits herself, her statement is not confirmed experimentally.

However, there is at least one important argument against the representations in (13). The most serious piece of evidence is provided by stems beginning with an extrasyllabic segment (sonorant). The examples presented in (15) show that (i) the resyllabification of a stem-initial extrasyllabic segment into the coda of a preceding vowel-final prefix takes place and (ii) the left edge of a stem and the left edge of a syllable do not have to coincide. Their alignment is optional as shown by the alternative syllabifications in (15).

(15) o+mdleć	o.mdleć	or	om.dleć	‘to faint’
po+mścić	po.mścić	or	pom.ścić	‘to revenge’
za+rdzewieć	za.rdzewieć	or	zar.dzewieć	‘to get rusty’

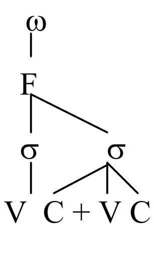
In light of the facts sketched above the data in (15) question the initial assumption that prefixes are separate prosodic words.[5] It cannot be the case that the same prefix followed by the same stem is sometimes a prosodic word and sometimes not. The conclusion that follows from the data in (15) is that prefixes are not prosodic words since they do not create domains for syllabification.[6] Other diagnostics which are helpful in determining prosodic words are analyzed below.

As far as suffixes are concerned, they are usually assumed to create together with a stem one prosodic word, cf. Kraska-Szlenk (1995). A convincing piece of evidence comes from the syllabification: the final consonant of a stem is always parsed into the onset of the following suffix. Consider the examples in (16).

(16) przedszkol+ak	przedszko.lak	‘nursery school child’ nom.sg.
odwiedzając+y	odwiedzają.cy	‘visitor’nom.pl.

The structures in (16) must be dominated by a prosodic word given the organization of a prosodic hierarchy and constraints on prosodic domination, cf. Selkirk (1995). In (17) a representation of a vowel initial suffix is shown.

(17)



[5] One may also conclude that prefixes ending in a consonant like those presented in (14) are prosodic words and those ending in a vowel as in (15) are not. It is indeed very difficult to prove this hypothesis because of the lack of relevant data. Words with a consonant-final prefix and a stem beginning with an extrasyllabic consonant (e.g. *pod+rdzewieć* ‘to start to rusty’) are rare. As expected, they are syllabified as *pod.rdzewieć*. However, if vowel-final prefixes were not prosodic words, the question would arise as to why the syllabification *o.mdleć* is possible.

[6] A possible explanation for these data would require a constraint militating against extrasyllabicity that outranks the alignment constraint mentioned above. This proposal has to be checked against various kinds of data which is beyond the scope of this article.

The representation in (17) shows that the structures in (16) are prosodic words, as shown in (18).

(18) [przed.szko.l+ak] $_\omega$
[od.wie.dza.ją.cy] $_\omega$

A different situation occurs in prepositional phrases. Final consonants of prepositions are never resyllabified into the onset of following vowel-initial word for the simple reason that the resyllabification across word-boundaries is not allowed in Polish, cf. Rubach and Booij (1990b). In (19), some examples confirming this generalization are given.

(19)	przed śniadaniem	przed.śniadaniem	‘before breakfast’
	po szkole	po.szkole	‘after school’
	nad miastem	nad.miastem	‘over the city’

To sum up, taking the syllabification as a diagnostic for determining prosodic words we come to the conclusion that suffixes create together with stems prosodic words, while prepositions and all other word classes, being never resyllabified, are not incorporated into following prosodic words. The prosodic status of prefixes is not unambiguous, especially if one considers the syllabification as the only diagnostic. Therefore, in order to find out adequate representations of prefixes, other factors have to be taken into consideration, cf. analyses given below.

1.3 Phonological processes

In the following I discuss some phonological processes whose domain is the prosodic word. These rules are: final devoicing (1.3.1), and Lower: vocalisation of yers (1.3.2).

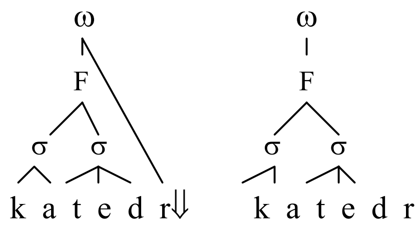
1.3.1 Final devoicing

Another piece of evidence for the role of a prosodic word in Polish can be gained from final devoicing. As has been argued by Rubach and Booij (1990), a prosodic word creates the domain for final devoicing in Polish. In this section I summarize this evidence. Relevant examples are shown in (20). Note that the process is motivated by morphophonemic alternations, e.g., pró[k] – pro[g]i ‘threshold’ nom.sg./nom.pl. go≥ą[p] - go≥ę[b]ia ‘pigeon’ nom.sg./gen.sg.

(20)	pró/g/	pró[k]	‘threshold’ nom.sg.
	gra/d/	gra[t]	‘hail’ nom.sg.
	go≥ą/b/	go≥ą[p]	‘pigeon’ nom.sg.
	g≥a/z/	g≥a[s]	‘stone’ nom.sg.
	gra/m/	gra[m⇓]	‘gram’ nom.sg.
	kate/dr/	kate[tr⇓]	‘cathedral’ gen.pl.

The last example in (20), in which the extrasyllabic sonorant *r* is devoiced shows that the prosodic word and not the syllable is the domain of final devoicing, cf. discussion on extrasyllabicity in section 2. In (21a) a representation is shown in which the devoicing of an extrasyllabic r is motivated by its prosodic word final position while the extrasyllabic *r* in (21b), is not devoiced because it is not linked to a higher constituent.

(21)
a. b.



As far as prepositions are concerned, their final consonants undergo devoicing only if they occur without the following noun, as shown in (22). Note that the voiced consonants in the underlying representations are motivated by alternations such as *po[d]e* ‘under’ and *na[d]e* ‘above’ in which a final vowel appears in some contexts, for details see 1.3.2.

(22)	po/d/ i na/d/ → po[t] i na[t]	‘under and above’
	po/d/ lub na/d/ → po[t] lub na[t]	‘under or above’

If the prepositions are followed by nouns, the final consonants do not devoice, cf. examples in (23).

(23)	nad miastem	na[d]. miastem	‘over the city’
	pod. ochroną	po[d]. ochroną	‘to be preserved’

This evidence suggests a prosodic structure as presented in (24) where both prepositions are prosodic words.

(24) $[pod]_{\omega}$ i $[nad]_{\omega}$

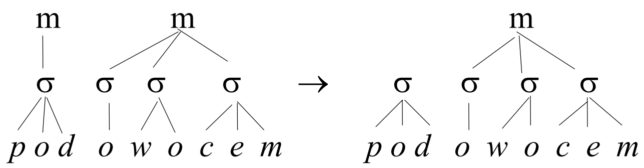
If *pod* and *nad* occur as prepositions (*po[d] owocem* ‘under a fruit’) and prefixes (po[d]oficer ‘non-commissioned officer’) they do not undergo final devoicing, but the evidence in (22) leads Rubach and Booij (1990) to the conclusion that *pod* and *nad* are prosodic words. In light of this conclusion Rubach and Booij propose either erasing the right bracket] of the prepositions when they occur in a proclitic position or erasing the node mot[7]. In (25)a and (25)b both proposals are illustrated by a phrase *pod owocem* ‘under a fruit’, cf. Rubach and Booij (1990:440).

[7] Mot is another term for a prosodic word.

(25)a. Erase the bracket] in a proclitic position

[pod] [owocem]→ [pod [owocem]]

b. Erase the node mot in a proclitic position



Both options presented in (25) account for the fact that prepositions which are prosodic words do not undergo final devoicing when they occur in a proclitic position. The structure in (25)b also shows that final devoicing cannot be syllable final because [d] remain voiced.

In contrast to *pod* and *nad*, two other prepositions *z* 'with' and *w* 'in' are not devoiced even if they occur in non proclitic position, cf. (26).

(26) z i w	→ [z] i [v]	'with and in'
z lub w	→ [z] lub [v]	'with or in'

The lack of final devoicing in an isolated position suggests that *z* and *w* are not prosodic words, as shown in (27). Since they consist of a single consonants, they also violate a word minimality condition.

(27) $*[z]_{\omega}$ $*[v]_{\omega}$

Additional evidence for (27) follows from the fact that *z* and *w* consist of a single consonant which is resyllabified to the following stem, e.g., z+robić zro.bić 'to do' inf. perf., cf. also additional evidence in Cetnarowska (this volume).

To sum up, the prosodic word creates the domain of final devoicing in Polish. Prefixes/ prepositions such as *pod* and *nad* undergoing final devoicing are prosodic words while others such as *z* and *w* remain voiced and therefore cannot be considered as prosodic words.

1.3.2 Lower: vocalisation of yers

Another piece of evidence supporting the importance of a prosodic word in Polish phonology is provided by a rule called Lower (vocalisation of yers), cf. Rubach (1984). In the following I review main points of Rubach's (1984) and Szpyra's (1986) approaches to Lower.

According to Rubach (1984), underlying abstract vowels called yers either show up on the surface as *e* [ɛ] (or y [→]) or they are deleted. This is shown in (28), cf. Rubach (1984:185). A yer is defined featurally as [+syll], [+high], and [-tense].

(28) a. Yer Surfacing (Lower)

$$\begin{bmatrix}\text{+syll}\\ \text{+high}\\ \text{-tense}\end{bmatrix} \rightarrow [\text{-high}] \;/\; \underline{\quad\quad}\ \text{Co} \begin{bmatrix}\text{+syll}\\ \text{+high}\\ \text{-tense}\end{bmatrix}$$

b. Yer Deletion

$$\begin{bmatrix}\text{+syll}\\ \text{+high}\\ \text{-tense}\end{bmatrix} \rightarrow \varnothing$$

The rules in (28) show that a yer is lowered to *e* before a yer occurring in the next syllable. Otherwise, the yer is deleted. An investigation of morphologically derived words with respect to Lower reveals that prefixes are separate prosodic words. This conclusion follows from a vowel alternation in prefixes because prefixes – in contrast to suffixes – create their own domains for Lower. In his derivational approach Rubach (1984) proposes that prefixes are separate prosodic words, in which Lower applies. An example of derivational steps yielding a prefix+stem+suffix structure is shown in (29), cf. Rubach (1984:227f). Note that after suffixation Lower reapplies, but its domain is enlarged: it is now a prosodic compound that consists of two prosodic words.

(29)

cycle 2	(roz î)$_\omega$(j îm)$_\omega$	(roz î)$_\omega$(j îm)$_\omega$
Lower	- -	- -
cycle 3	(roz î)$_\omega$(jîm+ov)$_\omega$	(roz î)$_\omega$(jîm+îc)$_\omega$
Lower	- -	- (jem+îc)$_\omega$
cycle 4	(roz î)$_\omega$(jîm+ov+1)$_\omega$	(roz î)$_\omega$(jem+îc+a)$_\omega$
Lower	- -	- -
Phonological Compound	((roz î)$_\omega$(j î m+ov+1)$_\omega$)$_\omega$’	(roz î)$_\omega$(jem+îc+a)$_\omega$
Lower Postcyclic	((roze)$_\omega$(j îm +ov+1)$_\omega$)$_\omega$’	((roz î)$_\omega$(jem+îc+a)$_\omega$)$_\omega$’
Yer Deletion	((roze)$_\omega$(jm +ov+1)$_\omega$)$_\omega$’	((roz)$_\omega$(jem+c+a)$_\omega$)$_\omega$’
	rozejmovy	rozjemca

Unfortunately, Szpyra (1989) observes that Rubach’s proposal leads to false outputs in some cases, e.g., structures such as (bezî)$_ω$(p≥î⎛+ov+1)$_ω$ ‘sexless’ or (odî)$_ω$(vî□+1+⎛)$_ω$ ‘delouse’ are incorrectly predicted to be *[bezepw⎛ow1] or *[odef□1⎛] instead of [bespw⎛ow1] and [otf□1⎛], respectively. In order to account for these and other forms, Szpyra (1989) claims that the same prefix may have a different prosodic representation which depends on the grammatical features of a stem. If a prefix is adjoined to a verbal stem which contains an alternating vowel, it forms together with a stem a prosodic word. In other cases the same prefix is a separate prosodic word. Both representations are shown in), cf. Szpyra (1989:215). (Pref=Prefix, C=consonant, î= alternating vowel, VS= verbal suffix, V=verb).

(30)

$$[\text{Pref+[\ ]]} \rightarrow \left[\begin{array}{l} (\text{Pref+ [C \ î C(+VS)]]}_{V})_{ω} \\ ([\text{Pref+})_{ω}\ ([\ \ ])_{ω} \end{array} \right.$$

In other words, the representations in (30) can be alternatively expressed as in (31a) and (31b), respectively.

(31) a. Prefixes with verbs containing a jer:
([Prefix+[verb]])$_ω$

b. Prefixes with other stems containing a jer:
((Prefix)$_ω$+noun])$_ω$

To sum up, the prosodic word is an indispensable constituent for the application of the rule called Lower which shows that the prosodic structure of prefixes depends on the grammatical features of stems they are aligned to.

2 Consonant clusters in Polish

In the previous section I showed that the foot and the prosodic word play an important role in Polish phonology. In the following I argue that both constituents are also important for the representation of consonant clusters.

I begin the investigation by presenting consonant clusters attested in word-initial and word-final position. The clusters are systematized from a qualitative point of view, i.e., in terms of sonority, and from a quantitative point of view, i.e. in terms of the number of segments occurring in a cluster. As far as sonority distinctions are concerned, they are limited to the distinction between obstruents and sonorants. Many clusters are presented with a subscript to the right, e.g. <$_{1,\ 2}$> which indicates the number of lexical items attested containing the given cluster. If the cluster occurs in some words that belong to the same semantic family but do not differ in grammatical category (noun, verb), it is counted as a single cluster. (< * > marks clusters attested in foreign words.)

Clusters in word-initial position

In the following word-initial clusters are presented. As far as obstruent+sonorant, obstruent+ obstruent, obstruent+obstruent+sonorant are concerned, only examples are provided. For a complete list see Rochoń (2000).

(32) Two-member consonant clusters

a. Obstruent+sonorant[8] [9] (examples)

pl	pw	pr	pn_2	$p〉_1$	tl_1	tl'_1	tw_1	tr	t〉	kl	kl'	kw
kr	kn	k〉	km'_3	bl	bw	br	$b〉_1$	dl_3	dw	dr	dn_1	dm_1
gl	gw	gr	gn	g〉	gm	gm'_1	t^sw_1	t^sn_1	t^sm_2	$t^{ã}w$	$t^{ã}m_1$	$t^{¿}m_1$
$t^{¿}m'$	v+l	vw	v+w	vr	v+r	v+m	vn	v+n	v〉	v+〉	sr	sw
sn	sm	ãl	ãr	ãw	$ãn_3$	ãm	ãm'	¿l	¿l'	¿r	¿〉	¿m'

b. Obstruent+obstruent (examples)

pt_1	ps	pã	$p¿_3$	px_1	tk_2	$tt^{ã}_1$	t□	tf	tf'	tx	$t^{ã}t_1$	$\mathbf{t^{ã}t^{ã}_1}$
$t^{ã}k_1$	$t^{ã}f_1$	$t^{□}p_1$	$t^{□}f'$	kp'_1	kt	$kt^{¿}_1$	kf	kf'	*ks	k¿	kã	bz_2
$b□_1$	bþ	db_1	dv_2	dv'_1	dþ	d^zv_1	$d^{ø}g_1$	$d^{ø}v'_1$	$\mathbf{d^{□}d^{□}_2}$	gb_1	gd	$gd^{ø}_1$
gv	gv'	gz	g□	g□	f+p	f+p'	fk	f+k	ft	f+t	$f+t^s_3$	ft^s
$ft^{□}$	$f+t^{□}$	$ft^{□}$	$f+t^{□}$	fs	f+s	f+□	f□	f+□	$f+x_1$	sp	s+p	sp'

c. Sonorant+obstruent

lg_1	lv_1	lv'_1	$lþ_2$	wk_1	wb_1	wg_1	wz_1	rt_1	rd_1	rd^z_2	rv_3	$rþ_2$
mg'_1	$mþ_3$	mã	mx_1									

d. Sonorant+sonorant

mn_3	m〉	ml	mr	mw	ln_1	$l〉_1$

optional: *lj

(33) Three-member clusters

a. Obstruent+sonorant+obstruent

plf_1	$pw‡_1$	trf_2	krf'_1	krf_1	krt_1	brd_1	brv'_1	drg_2	drv_1	drv'_1	$drþ_1$	grd_1

---

[8] I employ the symbols traditional in Slavic linguistics. The following is a list of these symbols and their IPA equivalents.

IPA transcription	Slavic transcription	IPA transcription	Slavic transcription
u	u	e~/en	ǀ/en
a~/om	≠/om	ℜ	ℜ
ϑ	〉	t͡s	c/t^s
t͡ʃ	‡/$t^{¿}$	t͡♣ (t͡Σ)	˜/$t^{ã}$
d͡z	Z/d^z	d͡⌉	Z⇔/$d^{ø}$
d͡ǀ (d͡Z)	Z®/$d^{þ}$	ʃ	□
♣ (Σ)	□	⌉	□
ǀ (Z)	□	v	v

[9] All affricates are treated as single segments as opposed to a sequence of stop+fricative, cf. Rubach (1994).

b. Obstruent+sonorant+sonorant

kln$_2$ kl〉$_1$ krn$_1$ *krj$_1$ brn$_1$ br〉$_1$ *brj$_1$ *prj$_1$ *trj *drj zmr$_1$ z+mr$_2$
z+m〉$_1$ smr$_2$

c. Sonorant+obstruent+sonorant

l□〉$_1$ mdl$_1$ mdl'$_1$ mdw$_1$ mgl'$_1$ mgw$_1$ mg〉$_1$ m□t$^□$$_1$ rþn$_1$ rþ〉$_1$

d. Obstruent+obstruent+obstruent

pãt^{ã}$_1$ tkf'$_1$ d□v'$_1$ tãp'$_2$ tãt$^□$$_1$ kãt$_1$ bzd$_2$ bþd$_2$ gþb'$_1$ gþd$_1$ f+pã$_2$ fsp fs+p
f+sp'$_2$ f+st f+sk f+sx$_1$ fãt^{ã}$_2$ f¿t$^{¿}$$_3$ v+zb v+zb'$_2$ v+zv$_2$ vzg$_2$ vzd$_2$ vþd$_1$ s+ps$_1$
spã s+pã s+p□$_1$ s+tf s+tf' stã s+tx skf s+kf skf' skã sk+ã s+st
s+xf ãt^{ã}f z+b∅$_1$ z+bþ$_2$ z+dv$_1$ z+dþ$_1$ z+gv zgþ z+gþ
colloquial: s+xã$_1$

e. Obstruent+obstruent+sonorant (examples)

pxw$_1$ pxl'$_1$ pxn px〉 tkn$_1$ tk〉$_1$ tkl'$_1$ txn$_1$ tx〉$_1$ tãn tãm'$_1$ bþm' gþm$_1$
gþm'$_1$ t^{s}kl'$_1$ t^{ã}kn$_1$ t^{ã}k〉$_1$ d$^{∅}$gn$_1$ d$^{∅}$g〉$_1$ f+pl$_1$ f+pw$_3$ f+pr f+tw f+tr fkl
f+kl fkw f+kw f+kr f+tr f+¿l$_1$ f¿r$_1$ f+¿r f+sw f+sn$_1$ f+xw$_1$ vbr
v+dr$_3$ v+dm v+gw vgl$_1$ v+gr$_1$ v+g〉$_1$ v+zl$_1$ vzr$_3$ v+zn$_3$ vz〉$_3$
vzm'$_1$ v+zm s+pw s+pl *spl' s+pl' spr s+pr s+tw s+tl str s+tr
*st^{s}j skw s+kw skr s+kr

f. Obstruent+obstruent+obstruent

pãt^{ã}$_1$ tkf'$_1$ d□v'$_1$ tãp'$_2$ tãt$^□$$_1$ kãt$_1$ bzd$_2$ bþd$_2$ gþb'$_1$ gþd$_1$ f+pã$_2$ fsp
fs+p
f+sp'$_2$ f+st f+sk f+sx$_1$ fãt^{ã}$_2$ f¿t$^{¿}$$_3$ v+zb v+zb'$_2$ v+zv$_2$ vzg$_2$ vzd$_2$ vþd$_1$ s+ps$_1$
spã s+pã s+p□$_1$ s+tf s+tf' stã s+tx skf s+kf skf'skã sk+ã
s+st s+xf
ãt^{ã}f z+b∅$_1$ z+bþ$_2$ z+dv$_1$ z+dþ$_1$ z+gv zgþ z+gþ
colloquial: s+xã$_1$

(34) Four-member consonant clusters

drg〉$_1$ drgn$_1$ pstr$_3$ pstã$_1$ s+trf s+krf$_1$ ∅d$^{∅}$bw$_1$ fstr$_1$ f+s+tã$_1$ f+s+kã$_1$
f+s+kr$_1$
v+z+dw$_1$ v+z+dr$_3$ v+z+gl$_2$

Clusters in word-final position

(35) Two-member clusters

a. Obstruent+ sonorant

pw pr pn p〉 tw tr tm kw kl kr *km *kn t$^□$m
t^{ã}m t+w *fl *fr fn sw sm ¿l ¿〉 ¿m □m □n x+w
xr xn *xm

b. Obstruent+obstruent

*pt pt^{ã} pt$^{¿}$ pã ps tf tã kt kf *ks t$^{¿}$p t^{ã}p t^{ã}t
ãt^{ã} ft ft^{s} ft$^{¿}$ sp st sk sf ãp *ãt ãx ¿p ¿t$^{¿}$
¿f xt xt$^{¿}$ xf

c. Sonorant+obstruent

*mp mt¿ *mf *ms mã m¿ nt nk nt^{s} nt□ *nt^{ã} *nf *nã
*ns 〉p 〉t^{ã} 〉t¿ 〉t^{s} lp lt lk lt^{s} wt^{ã} wf ws wã
*lf lx rf rp
rt rk rt^{s} rt^{ã} rt¿ rf rs rã r¿ rx jp jt *jk
jt^{s} jt^{ã} jt¿ jf *js jã wp wt wk

d. Sonorant+sonorant

ml mn *jl jm jn j〉 lm l〉 rm rl rn r+w r〉

(36) Three-member clusters

a. Obstruent+obstruent+obstruent

p+sk *kst t+^{s}tf[10] +stf stã ãt^{ã}p

b. Obstruent+obstruent+sonorant

stm str ãtr xtr

c. Sonorant +obstruent+obstruent

*mpt mst ntã ntf *nks *nkt nkf nãt 〉t¿p 〉+sk 〉¿t¿ lãt^{ã}
rpt^{s} rst rsk rãt rãt^{ã} r¿t¿ jst j¿t¿ jsk

d. Sonorant+obstruent+sonorant

mpr *mpl ntn ntr ntr nkr *ltr l¿〉

(37) Four-member clusters

a. Obstruent+obstruent+obstruent+obstruent

p+stf t¿+stf f+stf

b. Sonorant+obstruent+obstruent+obstruent

m+psk m+stf n+stf nt+^{s}tf〉+stf l+stf r+stf j+stf

(38) Five-member clusters

mp+stf

There are several reasons to believe that a significant number of word-initial and word-final consonant clusters shown above are not syllable-initial or syllable-final. One of the main reasons is that they violate Sonority Sequencing Generalisation presented in (40), cf. Selkirk (1984a:116), cf. also Hooper (1976), Murray and Vennemann (1983), Clements (1990), based on the Sonority Hierarchy for Polish in (39).

(39) Sonority Hierarchy for Polish, cf. Rubach and Booij (1990a,b)

obstruents < nasals < liquids < glides < vowels

[10] The suffix is /stv/ , however its first segment and the stem-final consonant constitute an affricate.

(40) Sonority Sequencing Generalization (SSG):

"In any syllable, there is a segment constituting a sonority peak that is preceded and/or followed by a sequence of segments with progressively decreasing sonority values."

In (41), I list some examples of clusters that violate the Sonority Sequencing Generalization in word-initial, cf. (41) and word-final position, cf. (41b).

(41) a.

lg	lv	lv’	lþ	wk	wb	wg	wz	rt	rd	rd^{z}	rv	rþ
l□〉	mdl	mdl’	mdw	mgl’	mgw	mg〉	m□t□	rþn	rþ〉			
b.												
pw	pr	pn	p〉	tw	tr	tm	kw	kl	kr	*km	*kn	t□m
$t^{\tilde{a}}m$	t+w	*fl	*fr	fn	sw	sm	¿l	¿〉	¿m	□m	□n	x+w
xr	xn	*xm	stm	str	ãtr	xtr	mpr	*mpl	ntn	ntr	ntr	

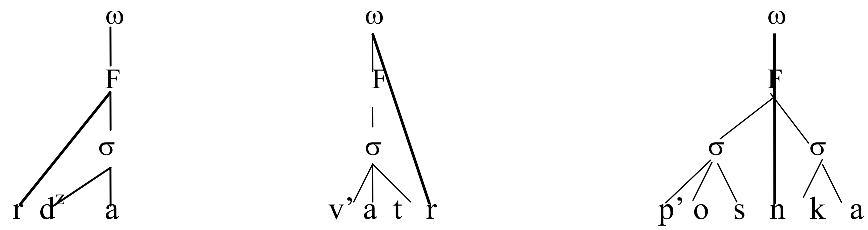
There are at least two arguments as to why word-initial segments such as *l* in *lg* or *n* in *pn* are not parsed into a syllable. First, as already mentioned they violate the SSG which in most languages is an inviolable principle organizing a syllable structure and, second, the consonant clusters listed in (41) are heterosyllabic when they occur in word-medial position. This is shown in (42).

(42)	[wk]ać ‘to sob’ inf.	pa[w.k]a	* pa[.wk]a	‘stick’ nom.sg.
	[rt]ęć ‘mercury’	na[r.t]y	* na[.rt]y	‘ski’ nom.pl.
	[rw]ać ‘to tear’ inf.	wy[r.v]a	* wy[.rw]a	‘breach’ nom.sg.

As far as word-final sequences of obstruent+sonorant are concerned, they are also never parsed into a coda as a whole sequence e.g. *bóbr bo.bra* ‘beaver’nom.sg./gen.sg. or *bob.ra* but never **bobr.a*. However, this evidence is not as strong as in the case of the word-initial clusters because of an independent cross-linguistic principle according to which a syllable has to have an onset. Nevertheless, the examples shown above indicate that the sonorants occurring at word-edges do not belong to a syllable.

Since the initial sonorants in (41a) and final ones in (41b) violate the SSG and are not parsed into a syllable when they occur in a word-medial position (and are not deleted), I propose that they are licensed by other prosodic categories such as the foot and the prosodic word. I show that a word-initial extrasyllabic consonant is attached to the foot and the word-medial and a word-final consonant is licensed by the prosodic word. The representations are shown in (43).

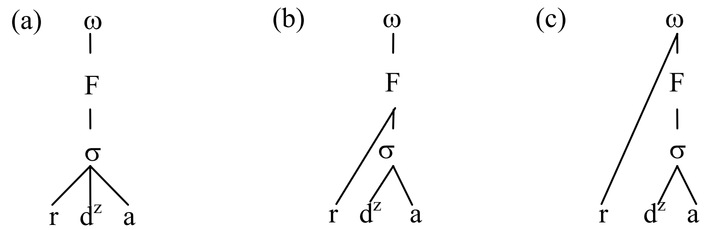
(43) word-initially word- finally word- medially



In the following I show some arguments favoring the proposal in (43).

Let us start with the representations of consonants in word-initial position. In (43) three possible representations of the word *rdza* ‘rust’ sg.nom. are shown. In (43a) the sonorant forms together with the following obstruent the onset of a syllable. In the second case it is attached to the foot and in (43)c it is linked to the prosodic word. In the following I shall argue that only the representation in (43)b is correct.

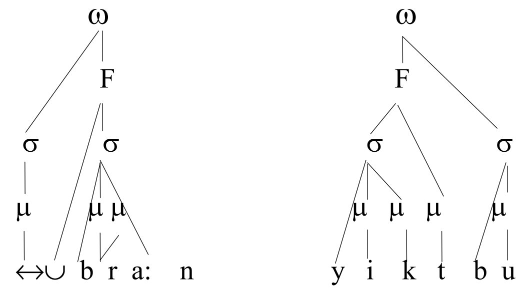
(44)



There are some important reasons why only the representation in (44)b is correct. They follow from (i) the extrasyllabic status of the sonorant, (ii) the behavior of the sonorant in phonological processes discussed below, (iii) the asymmetry between word-initial and word-medial/word-final extrasyllabic sonorants, (iv) the prosodic organization of morphosyntactic structures and (v) internal requirements of Optimality Theory, especially from the assumption that the violation of a constraint should be minimal.

Before discussing arguments in favor of the licensing role of the foot and the prosodic word in Polish phonology, it is worth mentioning that the importance of the licensing role of these constituents with respect to consonants is recognized in other languages as well, cf. Munster Irish (Green 1997, 1999), Arabic (Kiparsky 1999), French (Féry 1999), Georgian, Bella Coola (Cho and King 1999), and Polish (Rubach and Booij 1990b, Rubach 1997, Cho and King 1999). In (45) representations of words in Arabic, (Kiparsky 1999) and in Munster Irish (Green 1997) are given.

(45) Munster Irish Arabic (C and VC-dialects)



ω = prosodic word
F = foot
σ = syllable
μ = mora
∪ = accent

The representations in (45) are not accidental but are motivated by (i) phonological behavior of segments under consideration as well as (ii) the prosodic organization of morphosyntactic structures. Since the second motivation is of universal character and therefore important for the present study, I discuss it in detail.

According to assumptions made in Prosodic Phonology, sentences are organized into the Prosodic Hierarchy which consists of constituents such as the syllable, the foot, the prosodic word, the clitic group, the phonological phrase, the intonational phrase, and the phonological utterance as shown in (46) cf. Nespor and Vogel (1986:11).

(46) Prosodic Hierarchy

phonological utterance
ηγ
intonational phrase
γ
phonological phrase
γ
clitic group
γ
prosodic word
γ
foot
γ
syllable

The Prosodic Hierarchy is organized by some principles proposed by Nespor & Vogel (1986) and Selkirk (1981, 1984b, 1995). One of them is the Strict Layer Hypothesis, which demands that a prosodic constituent of a higher level (C^{i}) dominates only constituents on the next level down in the prosodic hierarchy, (C^{i-1}). This principle is stated in terms of the constraint in (47).

(47) Strict Layer Hypothesis

Strict Layer (Layer): A prosodic constituent of level C^i immediately dominates only constituents of the level C^{i-1}.

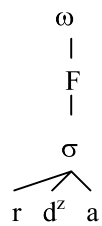
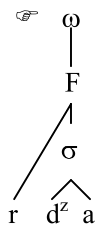
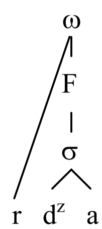
I assume that (i) Strict Layer is violable and (ii) violations of Strict Layer are 'gradient' which is shown by the examples given below.

The next constraint that selects the optimal representations is given in (48). It directly refers to the sonority hierarchy shown in (39). In contrast to SSG, the constraint in (47) also allows a sonority plateau, e.g., a sequence of two or more obstruents can be parsed into a syllable, cf. also the discussion below.

(48) *Son↘V: No decreasing sonority from the edges of the syllable towards its peak.

Since *Son↘V is inviolable, consonants which violate the constraint in (48) cannot be adjoined to the syllable, but according to *Layer* are licensed by the next prosodic level, i.e., the foot. This is illustrated by the tableau in (49) in which the conflict between **Son↘V* and *Layer* and the selection of the optimal representation are shown.

(49)

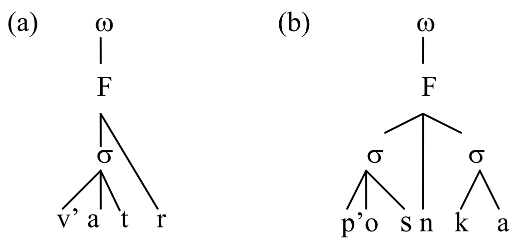
r d^z a	*Son↘V	Layer
a 	*!	
b ☞ 		*
c 		*!*

Although the first candidate in (49) perfectly satisfies Layer by incorporating all consonants into a syllable, it is not selected as optimal because it violates the high-ranked sonority constraint. This candidate shows that the optimal position for consonants following from Layer is the syllable onset that cannot be filled up by *r* because of the violation of sonority. The second candidate, however, does not violate *Son⭸V because the word-initial sonorant is linked to a foot. Consequently, it violates Layer only once by skipping the syllable level. For this reason it fares better than the third candidate, which incurs two violations of Layer by skipping both the syllable and the foot level.

The optimal representation in (49) differs from the representation proposed by Rubach (1997) who argues in favor of the representation (49)a Rubach (1997:566) poses a high-ranking constraint ALIGN LEFT (stem, σ) according to which the left edge of a stem coincides with the left edge of a syllable. In other words, this constraint requires the initial consonant to be parsed into the initial syllable. Since ALIGN LEFT is equally ranked with a sonority constraint, the decisive role is played by Layer which decides that a representation like the one in (49)a is selected as optimal. Since the representation is an optimal surface representation, a question arises as to why ALIGN LEFT (stem, σ) is a high-ranking in Polish, a language which shows edge-effects by virtue of its abundant extrasyllabic consonants in word-initial and word-final position and more importantly why the word-initial consonants which are parsed into a syllable are divided into a coda and an onset when they occur word-medially, cf. *kar.t*y card' nom.pl.

The mirror image of (49) might be obtained for extrasyllabic consonants in word-final codas. For example, the final sonorant in *wiatr* 'wind' nom.sg. could be attached to the foot, thereby avoiding violations of the *Son⭸V and incurring a minimal violation of Layer. The same conclusion could also be derived with respect to word-internal sonorants between obstruents or sonorants. Two hypothetical representations are shown in (50).

(50) Hypothetical representations



The possibility of incorporating all extrasyllabic sonorants into feet, which follows from structural requirements of the prosodic hierarchy as well as sonority conditions, remains to be shown. This will be a task of the next part of the article, in which I am going to show that the selected representation in (48) is correct while the structures in (50a) and (50b) are incorrect. This conclusion follows from independent phonological reasons such as the behavior of the extrasyllabic consonants in voicing assimilation and in degemination presented below. A supporting piece of evidence in favor of this proposal comes from optional deletions attested in casual speech.[11]

2.1 Regressive voicing assimilation

Regressive voicing assimilation in Polish is triggered by the final obstruent of a cluster. The examples in (51) show that the assimilation takes place not only word-medially but also across word-boundaries. (< # > indicates word-boundary)

(51) Obstruents clusters

≥y/□k/a	≥y[□k]a	'spoon' nom.sg.
gwia/zdk/a	gwia[stk]a	'star' dim.nom.sg.
samochʃ/d #s/≥awka	samochʃ[t s]≥awka	'S≥awek's car' nom.sg.
po□li/zg #s/amochodowy	po□li[sk s]amochodowy	'car skid' nom.sg.

However, if there is a sonorant between the obstruents, the assimilation is blocked but only when the sonorant occurs in word-initial position, as shown in (52).

(52) Obstruent(s)+sonorant+obstruent clusters

ry/k#lv/a	ry[k lv]a	'roar of a lion' nom.sg.
sma/k#rd/estu	sma[k rd]estu	'water-pepper taste'nom.sg.
wielko/□t□#≥b/a	wielko[□t□ wb]a	'size of the head'(pej.) nom.sg.
ob≥o/k#mg/wy	ob≥o[k mg]wy	'cloud of mist' nom.sg.

If a sonorant occurs in word-final or word-medial position, the assimilation between obstruents takes place, as illustrated by the examples in (53).

(53) sonorant in word-final or word-medial position

ry/tm#b/razylijski	ry[dm b]razylijski	'Brazilian rhythm' nom.sg.
wia/tr#z/achodni	wia[dr z]achodni	'westerly wind' nom.sg.
mę/dr/ek	mę[tr⇓k]a	'crafty person' nom.sg. / gen.sg.
Ję/dr/ek	Ję[tr⇓k]a	'Jędrek' nom.sg./gen.sg.

To sum up, the examples above show that extrasyllabic sonorants in word-initial position prevent voicing assimilation between obstruents while sonorants in word-medial and word-final positions do not. This indicates that the asymmetry follows from different prosodic representations of extrasyllablc sonorants and therefore the representations in (50) showing

[11] This asymmetry was shown by Rubach and Booij (1990b) within a derivational approach. For a detailed discussion see Rochoń (2000).

the incorporation of the critical consonants into the foot as in the case of the word-intial extrasyllabic segments cannot be correct.

2.2 Degemination

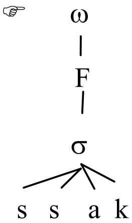
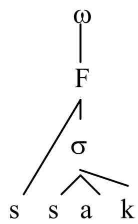
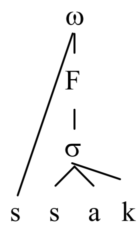
Further evidence for the asymmetry in the behavior (and representation) of word-initial extrasyllabic segments on the one hand and word-medial and word-final segments on the other comes from degemination, cf. Rubach and Booij (1990b). Consider the examples in (54) which show that two identical obstruents may occur in word-initial position.

(54) no degemination in word-initial position

/ssak/	[ss]ak	‘mammal’ nom.sg.
/d□d□/ownica	[d□d□]ownica	‘worm’ nom.sg.
/d□d□/ysty	[d□d□]ysty	‘rainy’ adj.nom.sg.masc
/t□t□/y	[t□t□]y	‘empty’ nom.sg.masc.

Evidence that the adjacent segments in (54) do not surface syllable-initially is that they are heterosyllabic intervocallically, e.g. las.so ‘lasso’ nom.sg., Kos.sak ‘Kossak’, Kamobo[d□.d□]a ‘Cambodia’nom.sg. The heterosyllabification of such clusters leads to the conclusion that they constitute neither true syllable onsets nor true syllable codas. However, the interaction of the high-ranked *Son↘V and Layer, proposed thus far, incorrectly selects a representation in which both consonants are parsed into the onset of the initial syllable. This is shown in (55).

(55)

s s a k	*Son↘V	Layer
a ☞ 		
b 		*!
c 		*!*

The selection of the candidate in (55) shows that *Son↘V does not block the parsing of obstruent segments into the same syllable since they do not violate it by being equally sonorous.[12] Therefore another constraint has to be responsible for nonparsing of geminates into the onset/coda of a syllable. In (56) the general formulation of the constraint prohibiting syllabification of geminates as well as its specific formulations with respect to the onset and the coda are given.

(56) *GEMINATE$_{SYLLABLE}$: Geminates are not parsed into the same syllable.
*GEM$_{ONSET}$: Geminates are prohibited in the onset.
*GEM$_{CODA}$: Geminates are prohibited in the coda.

These constraints were originally incorporated in the Obstruent Sequencing Constraint proposed by Rubach and Booij (1990a:124) which says: 'With non-identical obstruents there is no requirement of sonority distance'. In the present study they are separated from *Son↘V in order to avoid contradictory statements: a sonority plateau is tolerated in obstruent sequences, and a sonority plateau is not tolerated in sequences of obstruents that are identical. In order to avoid this contradiction, I proposed separate constraints in (56) that are sensitive only to geminates. The role of *GEM is illustrated by the tableau in (57).

[12] *Son↘V forces however heterosyllabification of sonorant similar segments.

(57)

	*GEM$_{ONSET}$	*GEM$_{CODA}$	*Son↘V
las.so			
la.sso	*		
lass.o		*	

The heterosyllabified word *las.so* ‘lasso’ nom.sg. emerges as optimal since it neither incurs a violation of *GEM$_{ONSET}$ nor *GEM$_{CODA}$. Other candidates must be excluded from consideration because they would syllabify geminates as onsets or as codas, which leads to the fatal violation of *GEM$_{ONSET}$ and *GEM$_{CODA}$, respectively.

Both constraints, *GEM$_{ONSET}$ and *GEM$_{CODA}$, are also sensitive to geminates occurring in all positions. The examples provided in (58) illustrate word-initial geminates. *GEM$_{ONSET}$ prohibits them from being syllabified. As a consequence, they must be attached to a higher prosodic constituent. Since the foot is the next level up from the syllable in the prosodic hierarchy, the extrasyllabic consonant is linked to the foot in order to fulfill Layer and not to allow geminates to be parsed into a syllable. Consider the tableau shown in (58).

(58)

ssak	*GEM$_{ONS}$	*Son↘V	Layer
PrW Ft σ s s a k			*!*
PrW Ft σ s s a k	*!		
☞ PrW Ft σ s s a k			*

The tableau in (58) shows that the third candidate, which links the unsyllabified consonant to the foot, emerges as optimal. It fares better on the high-ranking *GEM$_{ONS}$ than the second candidate; it also satisfies Layer better than its most serious competitor, i.e., the first candidate.

Let us now proceed to the critical examples illustrating the discrepancy between intervocalic medial geminates and medial nonintervocalic geminates. In (59) the outputs of the suffixation of the adjectival suffix /n/ are shown.

(59) a.

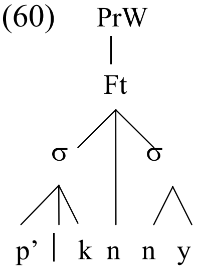
diakon	diakon+ny	diako[nn]y	‘deacon’ noun nom.sg. /adj.nom.sg.masc.
p≥yn	p≥yn+ny	p≥y[nn]y	‘liquid’ noun nom.sg. /adj.nom.sg.masc.
obron+a	obron+ny	obro[nn]y	‘defense’ noun nom.sg. /adj. nom.sg. masc
ko〉	ko〉+ny	ko[nn]y	‘horse’ noun nom.sg. /adj.nom.sg.masc.

b.

przyja□〉	przyja□〉+ny	przyja[zn]y	‘friendship’ noun nom.sg. / adj. nom.sg.masc.
pi| kn+o	pi| kn+ny	pi| [kn]y	‘beauty’ noun nom.sg. / adj. nom.sg.masc.

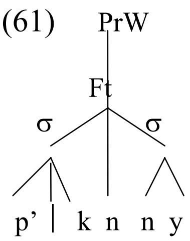
The suffixation in the words provided in (59)a does not bear any influence on the final sonorant. In the examples shown in (59)b, on the other hand, the stem-final sonorant is deleted. If it were not deleted we would have a medial sequence consisting of an obstruent followed by two identical sonorants. Since the constraint *GEM$_{\text{ONSET}}$ disallows the parsing of the sonorants in the onset and the *Son↘V prohibits their parsing into the coda, the medial sonorant cannot be syllabified. The ranking stated in (58) suggests that the offending sonorant is linked to the foot, cf. the representation in (60).

(60)



If this were indeed the case, then we would expect no difference between word-initial and word-medial geminates. But the crucial difference between the two is that the former are not deleted and the latter are. Hence, medial geminates must differ in their representation from word-initial geminates. This asymmetry can be expressed by linking the consonant to the next prosodic constituent, i.e., the prosodic word, cf. (61).

(61)



A similar pattern is seen in word-final geminates. The words provided in (62) show that the last consonant of geminates occurring word-finally is deleted.

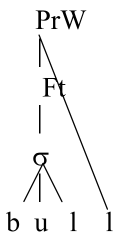
(62) Kano[ss]a	Kano[s]		‘Canossa’ nom.sg./gen.pl.
Kamobo[d□.d□]a	Kamobo[d□]		‘Cambodia’nom.sg./gen.pl.
less+ow+y	less	le[s]	‘loess’ adj. nom.sg./ noun nom.sg.

The deletion is attested if sonorant sequences are attested in a word-final position. This is illustrated by the examples in (63).

(63) bull+a	bull	bu[l]	‘bull’ nom.sg./gen.pl.
will+a	will	wi[l]	‘residence’ nom.sg./gen.pl.
idyll+a	idyll	idy[l]	‘idyll’ nom.sg./gen.pl.
sawann+a	sawann	sawa[n]	‘savanna’ nom.sg./gen.pl.
fontann+a	fontann	fonta[n]	‘fountain’ nom.sg./gen.pl.
nowenn+a	nowenn	nowe[n]	‘novenna’ nom.sg./gen.pl.

Similar to medial geminates, they cannot be linked to the syllable or to the foot, but must be linked to the prosodic word, cf. (64).

(64)



Although the representations in (58), (61) and (64) display an asymmetry in the representation, they do not show why the geminates in medial and final position are deleted. An additional constraint is responsible for the deletion of geminates. From the presented examples it follows that only geminates linked up to the foot level are prosodically licensed. If a part of a geminate is linked by a higher level than the prosodic foot, then it has to be deleted. This constraint will be not formally stated here as it requires cross-linguistic evidence. It has to be considered rather as a proposal of a constraint that is able to account for degemination in Polish.

In the word-final position the situation is different because one of the consonants is deleted. Relevant examples are shown in (65).

(65) idyll+a	idyll	idy[l]	‘idyll’ nom.sg./gen.pl.
sawann+a	sawann	sawa[n]	‘savanna’ nom.sg./gen.pl.

The data in (65) show that attaching the last consonant to the foot would be not correct because consonants attached to the foot do not undergo deletion as shown by the optimal candidate in (55). The parsing will also attach the last consonant to the prosodic word. Similarly, the part of the identical two-consonant sequence is deleted in the nonintervocalic word-medial position.

In sum, If two identical or nearly identical segments occur in word-medial or word-final position, one of them is elided. This process shows again the asymmetry between segments occurring in different positions of a word, i.e. between word-initial on the one hand and word-medial and word-final on the other hand and indicates that the former are attached to the foot and the latter to the prosodic word.

2.3 Optional deletions of extrasyllabic consonants in casual speech

In casual speech some generalizations concerning the behavior of extrasyllabic consonants can be made. Interestingly, extrasyllabic sonorants are often deleted if they do not occur in word-medial or word-final position. Otherwise they are never dropped. In (66) I provide some examples with extrasyllabic segments in word-initial position. As already mentioned, they do not undergo deletions.

(66) no deletion in word-initial position

/mx/u	[mx]u	‘moss’ gen.sg.
/rt/ęć	[rt]ęć	‘mercury’ nom.sg.
/wb/a	[wb]a	‘head’ pej.gen.sg.

In (67) a different situation is shown. Extrasyllabic consonants occurring in word-medial and word-final position are often deleted in casual speech.

(67) deletions of segments in word-medial and word-final positions

ja/błk/o	ja[pwk]o	ja[pk]o	‘apple’ nom.sg.
ga/rnk/ów	ga[rnk]ów	ga[rk]ów	‘pot’ gen.pl.
my/śl/	my[śl]	my[ś]	‘thought’ nom.sg.
pomy/s≥/	pomy[sw]	pomy[s]	‘idea’ nom.sg.

To sum up, the optional deletions confirm the generalization stated above that there is a clear asymmetry between extrasyllabic sonorants in word-initial position on the one hand and in word-medial/word-final position on the other hand. Again, this asymmetry is mirrored in the prosodic representation of consonants.

3 Summary

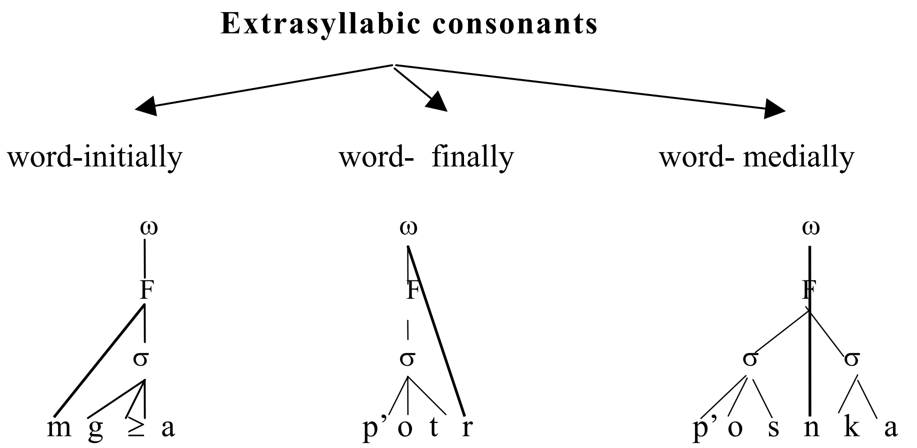
The behavior of extrasyllabic segments in the processes I discussed, i.e., regressive voicing assimilation, degemination, and optional deletion, is summarized in the table in (68), which shows a different behavior of word-initial extrasyllabic segments on the one hand and word-medial and word-final extrasyllabic segments on the other hand.

(68)

	extrasyllabic consonants		
	word-initially	word-medially	word-finally
Voicing assimilation	No	Yes	Yes
Degemination	No	Yes	Yes
Optional deletions	No	Yes	Yes

I propose that this asymmetry follows from the representation of segments as shown in (69), in which the word-initial extrasyllabic sonorant is attached to the foot, and the word-medial and word-final extrasyllabic sonorant are licensed by the next prosodic constituent in the Prosodic Hierarchy , i.e., the prosodic word.

(69)



In addition, these representations show that the higher prosodic levels such as the foot and the prosodic word are more tolerant of onset clusters than the syllable in a sense that they create a location for ill-formed clusters from a sonority point of view.

Finally, the present study shows that the licensing level determines the 'stability' of segments: consonants incorporated into the syllable or into the foot are more stable because they are never obligatorily or optionally deleted, in contrast to word-medial or word-final extrasyllabic segments which easily undergo deletion.

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Crossing Word Boundaries: Constraints for Misaligned Syllabification[1]

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1 Introduction

In this work, I examine a set of languages which appear to require resyllabification post-lexically; in less derivational terms, a word's syllabification in isolation differs from its syllabification in a phrase-internal context. Although many people, myself included, have been looking at such cases in isolation over the years, I bring together several examples here to see what features they share and how an Optimality Theory analysis improves upon rule-based derivational approaches.

I show that the interaction of word edges in phrases can be analyzed using alignment constraints in a monostratal Optimality Theory framework (henceforth OT, Prince and Smolensky 1993, McCarthy and Prince 1993a). Across-word syllabification results when constraints aligning word boundaries with syllables edges are outranked by constraints on well-formed syllable structures. By submitting entire phrases as input to syllabification, multiple levels of syllabification are unnecessary, in contrast to multi-level theories such as lexical phonology (Kiparsky 1982, Mohanan 1982) and multi-level OT (McCarthy and Prince 1993b). Furthermore, I show an advantage of the OT perspective: constraints for word-edge syllabification are not turned off, but merely overridden in cases in which phrasal position plays a role in syllabification. Such constraints can still exert themselves in the grammar in other circumstances, despite being outranked, which is exactly the prediction of the OT architecture.

2 Optimality Theory

I assume basic familiarity with a correspondence version of Optimality theory (McCarthy and Prince 1995), and will mention only a few relevant points here. The correspondence constraints include those in (1), parametrized for consonants, vowels, and features, which penalize any deviations between input and output forms.

(1) Correspondence Constraints (McCarthy and Prince 1995, p. 264)

(a) MAX-IO:	Every segment of input has a correspondent in output.
(b) DEP-IO:	Every segment of output has a correspondent in input
(c) IDENT(F)-IO:	Correspondent segments are identical in feature F.

[1] I thank the audience at the DGfS annual meeting, March 2000, in Marburg, for their comments on the oral version of this paper. In particular, I also thank T. Alan Hall and Bożena Cetnarowska for discussion afterwards. Any and all remaining errors of fact or interpretation are my own.

I formulate the interaction of words and syllables in terms of alignment constraints; the general form of such constraints is shown in (2):

(2) Generalized Alignment Constraint (McCarthy and Prince 1993a:2)
ALIGN (Cat1, Edge1, Cat2, Edge2) $=_{def}$
$\forall$ Cat1 $\exists$ Cat2 such that Edge1 of Cat1 & Edge2 of Cat2 coincide.
Where Cat1, Cat2 $\in$ Pcat U Gcat & Edge1, Edge2 $\in$ {Right, Left}

Alignment constraints are parametrized for various categories, whether prosodic or grammatical, and edges, either left or right. In languages whose words are syllabified without reference to phrasal context, the constraints given in (3) rank high.

(3) Constraints against Cross-word syllabification

(a) ALIGN(Wd,L,σ,L) = ALIGN-L(Wd, σ):	the left edge of each word aligns with the left edge of a syllable.
(b) ALIGN(Wd,R, σ,R) = ALIGN-R(Wd, σ):	the right edge of each word aligns with the right edge of a syllable.

When highly ranked, these constraints enforce the alignment of word and syllable boundaries, so that syllables do not straddle word boundaries. When lower ranked than other phonological constraints, however, constraints (3a) and (3b) can be violated, resulting in syllabification across words as the optimal output. The ranking of (3a-b) in an OT grammar will allow us to do both word and phrasal syllabification in a single stage of parallel constraint evaluation. In section 3, I examine four languages as case studies of the factors causing syllable/word misalignment; these show that constraints on each part of the syllable (onset, nucleus, coda) can be responsible for misalignment. In section 4, I show that two of these languages give evidence that the syllable/word alignment constraints play a role in phrasal syllabification, though they are outranked, as predicted in OT.

3 Phrasal Syllabification

3.1 Misalignment in Spanish

Spanish provides a straightforward example of syllabification across word boundaries caused by the requirement that syllables should have onsets (Harris 1983, 1993; Hualde 1992). The constraint requiring onsets (4) is familiar from the literature, and is widely attested cross-linguistically.

(4) ONSET: Every syllable begins with a consonant (McCarthy and Prince 1993a: 20)

In phrase-initial position, an onsetless syllable is tolerated, as in (5a). Word-internally, ONSET ensures that a single intervocalic consonant appears in onset rather than coda (5a-c). Phrase-internally, ONSET plays the same role, ensuring that a single intervocalic consonant is in onset position, as in (5d-f).

(5)	a. /asules/	[.a.su.les.][2]	"blue"
	b. /komida/	[.ko.mi.ða.]	"food"
	c. /kopa/	[.ko.pa.]	"cup, goblet"
vs.	d. /grandes#ojos#asules/	[gran.de.<u>so</u>.jo.<u>sa</u>.su.les.]	"big blue eyes"
	e. /asul#oskuro/	[.a.su.<u>los</u>.ku.ro.]	"dark blue"
	f. /klub#elegante/	[.klu.<u>βe</u>.le.ɣan.te.]	"elegant club"

As onsetless syllables are tolerated phrase-initially, correspondence constraints such as MAX-IO(V) and DEP-IO(C) outrank ONSET; otherwise, we would have vowel deletion (a MAX-IO(V) violation) or consonant epenthesis (a DEP-IO(C) violation) to resolve the lack of onset. In Tableau 1a, we see that the presence of the ONSET constraint favors the parsing of single intervocalic consonants into onset rather than coda position. The constraints aligning word and syllable boundaries play no role in word-internal evaluation; at phrase edges, syllable and word edges align.

Tableau 1a Phrase-initial and word-internal /asules/ "blue"

Candidates	Max-IO(V)	Dep- IO(C)	ONSET	Align-L (Wd, σ)	Align-R (Wd, σ)
.su.les.	*!<a>				
.ʔa.su.les.		*!(ʔ)		*	
.as.u.les.			**!		
☞.a.su.les.			*		

However, phrase-internally, syllabification crosses word boundaries in order to satisfy ONSET, resulting in violations of the constraints from (3), which are outranked. Thus, in Tableau 1b, we see that ranking these constraints lower than ONSET gives syllabification across words as the optimal result, despite the misalignments of words and syllables.

[2] I use '.' for syllable boundaries, and '#' for word boundaries. Underlining in (5d-f) is meant only to draw the eye to the crucial syllabification crossing word boundaries.

Tableau 1b Phrase-internal /grandes#ojos#asules/ "big blue eyes"

Candidates	Max-IO(V)	Dep- IO(C)	Onset	Align-L (Wd, σ)	Align-R (Wd, σ)
.gran.des.#jos.#su.les.	*!*<o,a>				
.gran.des. ʔ#o.jos. ʔ#a.su.les.		*!*(ʔʔ)		**	
.gran.des#.o.jos.#a.su.les.			*!*		
☞.gran.de.s#o.jo.s#a.su.les.				**	**

The overall ranking for Spanish is therefore the one shown in (6).

(6) { MAX-IO(V), DEP-IO(C) } >> ONSET >> { ALIGN-L(Wd, σ), ALIGN-R(Wd, σ) }

Syllabification within a phrase resembles syllabification within a word. Though the /s/ of *grandes* may be in a coda when the word is spoken in isolation, that is because a word in isolation is a phrase, and misalignment at the edges is not an option, even when important syllable phonotactics are at stake. The same /s/ of *grandes* can be an onset phrase-internally without resyllabification, so long as constraints evaluate entire phrases in parallel. Hence, distinct syllabifications do not entail multiple syllabification; both are attempting to satisfy the most important phonotactics at the expense of the least.

3.2 Misalignment in Italian

The second case study, Italian, offers two examples of the misalignment of syllables across word boundaries. Like Spanish, cross-word syllabification results from the interaction of syllable phonotactics with alignment constraints; unlike Spanish, where the requirement of a consonant in onset position was at issue, in Italian the dominant phonotactics limit the permissible onsets and codas. The analysis here is based on Wiltshire and Maranzana (1999).

The first example involves geminate consonants. Consonant length is generally distinctive word internally in Italian, but a few segments (e.g., [ts], [ʃ] and [ʎ], are always long except phrase-initially, as shown in (7a-c).

(7)	a.	[.faʃ.ʃa.]	"bandage"	vs.	*[faʃa]
	b.	[.ʃu.pa.to.]	"ruined"		*[ʃʃupato]
	c.	[.ca.saʃ.ʃu.pa.ta.]	"ruined house"		

I treat geminates as two consonantal slots here, though a moraic analysis is also possible (see Davis 1999 for a discussion of the representation of geminates). Geminates and other two obstruent clusters, when they appear word and phrase-internally, are syllabified as a coda plus onset. This results from the fact that standard Italian onsets are limited to clusters such as obstruent+glide and obstruent + liquid.[3] Italian onsets thus require an increase in sonority, based on a scale of sonority such as that in (8), proposed by Davis (1990) in his analysis of Italian onsets:

(8) Sonority Hierarchy for Italian (Davis 1990)

voiceless	voiced	non-cor	cor			glides	
stops <	stops <	frics <	frics	< n	< m <	liq <	vow
1	2	3	4	5	6	7	8

Sonority sequencing refers to the increasing sonority before the syllable peak and decreasing sonority following the peak. Languages may impose a minimal sonority distance requirement on these increases and decreases (Steriade 1982, Selkirk 1984), such as a requirement that onset segments differ in sonority by some minimal amount. In OT, the minimal sonority distance requirements can be seen as a set of constraints universally ranked from least to most strict, with different languages differing in which of these constraints can be violated due to other constraints ranked in between.

(9) a. *EQUALSON — Syllable margins do not contain segments of equal sonority. (aka*<1DIFSON)

b. *<2DIFSON — Syllable margins do not contain segments that differ in less than 2 degrees of sonority.

c. *<4DIFSON — Syllable margins do not contain segments that differ in less than 4 degrees of sonority.

Universal ranking: *EQUALSON (*<1DIFSON)>>*<2DIFSON >>*<4DIFSON

In Italian, stops followed by liquids and glides make good onsets, but consonants of equal sonority are never permitted in onset position. The constraint *EQUALSON therefore ranks high, and, by this ranking, geminates, which consist of two consonants of equal sonority, are associated with the coda of one syllable and the onset of another word and phrase-internally.

In order for such syllabifications to be chosen as optimal word and phrase-internally, *EQUALSON must outrank the widely attested NOCODA constraint from (10), as one half of the geminate is forced into coda position.

(10) NOCODA: Syllables end with a vowel.

[3] Italian has a few other rare but permissible onset clusters, such as /pn/ and /kn/; the minimal sonority distance requirement of +4 will allow these as onsets according to Davis's scale in (8).

Tableau 2a illustrates that two other correspondence constraints must also rank high in Italian: DEP-IO(V), which bans epenthesis as a solution to an onset or coda cluster of consonants with equal sonority, and MAX-IO(C), which bans consonant deletion. Note that the alignment constraint on words and syllables is inactive in the word-internal case.

Tableau 2a Word-internal *fascia* "bandage" = [.faʃ.ʃa.]

Candidates	*Equal Son	Dep-IO (V)	Max-IO (C)	No Coda	Align-L/R (Wd,σ)
fa. ʃʃa.	*!				
faʃʃ.a.	*!			**	
fa. ʃa. ʃa.		*!(a)			
.fa. ʃa.			*!<ʃ>		
☞ faʃ.ʃa.				*	

Phrase-internally, as in Tableau 2b, we have evidence that the word/syllable alignment constraints are violable in order to satisfy *EQUALSON. The result is that word boundaries are ignored, and phrase-internal and word-internal syllabification look identical.

Tableau 2b Phrase-internal *casa sciupata* "house ruined" = casa[ʃ.ʃ]upata

Candidates	*Equal Son	Dep-IO (V)	Max-IO (C)	No Coda	Align-L/R (Wd, σ)
kasa.# ʃʃupata	*!				
kasa#ʃʃ.upata	*!			**	**
kasa.# ʃa. ʃa...		*!(a)			
kasa.# ʃa...			*!<ʃ>		
☞kasa#ʃ.ʃupata				*	*

A different result is seen in phrase-initial position, where there is no option for the word-initial geminate to be realized with its first half in a coda. Here the ranking gives us deletion of the word-initial consonant, so that MAX-IO(C) is clearly outranked by *EQUALSON and DEP- IO(V). Again, (mis)-alignment of words and syllables is not an option here, since there is no previous word to syllabify with.

Tableau 2c Phrase-initial *sciupata* "ruined" = [.ʃu.pa.ta.]

Candidates	*Equal Son	Dep-IO (V)	Max-IO (C)	No Coda	Align-L/R (Wd,σ)
. ʃʃu.pa.ta.	*!				
.iʃ.ʃu.pa.ta.		*!(i)			*
☞ . ʃu.pa.ta.			*<ʃ>		

Thus the behavior of geminates in phrase-internal vs. phrase-initial position appears different, but can be handled by the same set of constraints. The same high ranked syllable phonotactic, which limits onset and coda clusters, ensures that geminates are either split between two syllables (both within and across words) or shortened to a single consonant (phrase-initially).

The second example of misalignment in Italian involves word-initial clusters of /s/ plus a consonant and the doubling of initial consonants known as *raddoppiamento sintattico* (Chierchia 1986, Saltarelli 1970, Vogel 1977). When a word ends in a stressed vowel, the consonant beginning the following word may be doubled (11a-b). I will return to the truly doubling types later, but first note that in (11c-d), misalignment makes the standard doubling of an initial consonant unnecessary.

(11)	a. /pulita/	[p]ulita	"clean"	cittá[pp]ulita	"a clean city"
	b. /triste/	[t]riste	"sad"	cittá[tt]riste	"a sad city"
	c. /ʃupata/	[ʃ]upata	"ruined"	cittá[ʃʃ]upata	"a ruined city"
	d. /sporko/	[sp]orco	"filthy"	cittá[sp]orca	"a filthy city"

In Wiltshire and Maranzana (1999), we analyzed the phenomenon as the effect of the constraint PKPROM, which motivates misalignment or insertion of an initial consonant in order to make a stressed syllable heavy:

(12) PKPROM: x is a more harmonic stress peak than y if x is heavier than y.
(Prince and Smolensky 1993: 39)

Thus, a form like **cit.tá.pulita,* with a light stressed syllable *tá,* is less harmonic than one like *cittáp.pulita,* which has the stressed syllable closed with a consonant; in some cases the consonant closing the stressed syllable is epenthetic, as in (11a-b), and in other cases, it is underlying, as in (11c-d).

Looking more closely at the (11d) case, we see that /sC/ clusters are tolerated phrase-initially, despite violating the constraint *<4DIFSON from (9). Thus, *<4 DIFSON must be outranked by the correspondence constraints MAX-IO(C) and DEP-IO(V), leaving its violation as optimal to the alternatives, phrase-initially.

Tableau 3a: Phrase-initial sC *specchio* "mirror" = [.spek.kj.o]

Candidates	*Equal Son	Dep-IO (V)	Max-IO (C)	*<4Dif Son	No Coda
.is.pek.kjo		*!(i)			**
.pek.kjo			*!<s>		*
☞ .spek.kjo.				*	*

In phrase-internal position, however, *<4DIFSON can be satisfied where possible by syllabification of the /s/ into coda position with a preceding word-final vowel. The word-syllable alignment constraint, as well as NOCODA, therefore ranks lower than *<4DIFSON.

Tableau 3b: Phrase-internal sC *cittá sporca* "filthy city" = [cittás.porka]

Candidates	*Eq Son	Pk Prom	Dep-IO	*<4Dif Son	No Coda	Align-R/L (Wd,σ)
cittá.#sporka		*!		*		
cittás#.sporka			*!	*		
☞ cittá#s.porka					*	*

PEAKPROM is included in Tableau 3b to show that it is satisfied in such cases, so that the doubling seen in *raddoppiamento sintattico* is unnecessary. I return to the doubling of (11a-b) in section 4.2.

Thus, we have seen that, in Italian, syllables cross word boundaries in order to satisfy onset restrictions against geminates and /sC/ clusters, as well as correspondence constraints DEP-IO(V) and MAX-IO(C). In both Italian and Spanish, we are seeing syllable phonotactics on the onset, whether requiring or restricting them, drive syllabification across words. These two cases also involve the syllabification of an entire segment with material from a different word; the segment can be any consonant in Spanish and the /s/ of /sC/ clusters in Italian. For the geminates in Italian, it is possible that less than a full segment is spread, depending on whether a geminate is considered to be two C-slots or a consonant with a mora. In the next two case studies, we see clearer cases of subsegmental misalignment across words, involving moras and features.

3.3 Mora Misalignment in Luganda

Luganda shows two types of compensatory lengthening (CL) which apply within morphemes, across morpheme boundaries, and across word boundaries within a phonological phrase (Clements 1986, Herbert 1975, Tucker 1962). In the first, prenasalization lengthening, nasals which are preceded by vowels and followed by stops or fricatives surface as prenasalization on the following consonant, while the preceding vowel is realized as long, as shown in (13):

(13) Prenasalization lengthening

	a. /ku+linda/	[kulii^{n}da]	"to wait"
	b. /mu+lenzi/	[mulee^{n}zi]	"boy"
	c. /mu+ntu/	[muu^{n}tu]	"person"
	d. /ba+ntu/	[baa^{n}tu]	"people"
	e. /#buta+lab+a# #njovu/	[butalabaa^{n}jovu]	"to not see elephants"
	f. /#si+agala##mva/	[saagalaa^{m}va]	"don't like vegetable relish'
c.f.	g. /mva/	[m̩va]	"vegetable relish"

The second type of CL, glide formation lengthening, results when a high vowel is followed by a vowel in another morpheme; the first vowel is realized as the corresponding glide, while the second is realized as a long vowel, as in (14).

(14) Glide Formation lengthening

a. /li+ato/	[l^{y}aato]	"boat"
b. /ki+uma/	[k^{y}uuma]	"metal object"
c. /mu+oyo/	[m^{w}ooyo]	"soul"
d. /mu+iko/	[m^{w}iiko]	"trowel"
e. /o+lu+naku##o+lu+o/	[olunak^{w}ool^{w}o]	"that day"
f. /a+ba+kulu##a+ba+o/	[abakul^{w}aabo]	"those elders"

To see how the two forms of compensatory lengthening involve misalignment of a mora across a word boundary, consider the structures in (15):

(15) Subsyllabic segment crosses word boundaries:

a.
```
σ σ σ     σ
[μ μ μ  μ]Wd [μ μ]Wd
sa a ga la   a  ᵐva
```

b.
```
σ σ σ  σ     σ
[μ μ μ  μ]Wd[μ  μ]Wd
o lu nakʷo    olʷo
```

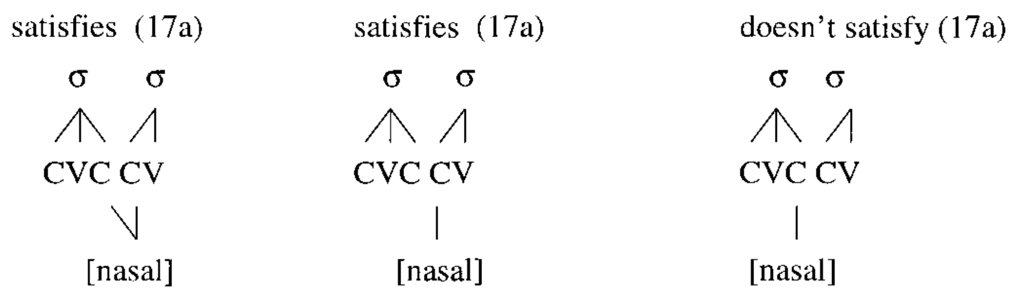
In (15a), the mora from the /m/ of /mva/ is syllabified with the preceding vowel of the preceding word, making it long, though the mora is part of the underlying form of the second word. Similarly, in (15b), the mora of the word-final vowel is realized in a syllable that contains the initial vowel of the following word.

In Wiltshire (1999), I connected the two types of CL in an OT account involving the satisfaction of the correspondence constraints in (16a-c), while violating the constraint (16d). That is, moras and features are preserved at the expense of the input location of some mora.

(16)	a. MAX-IO(μ)	Every mora of the Input has a correspondent in the Output. (Rosenthall 1997)
	b. MAX-IO([nas])	Every instance of [nasal] in the Input has a correspondent in the Output.
	c. MAX-IO([V-feat])	Every instance of [V-feat] in the Input has a correspondent in the Output.
	d. IDEN-IO(μ)	Correspondent segments in Input and Output have identical values for weight. (Rosenthall 1997)

The driving force behind the prenasalization is (17a); a coda condition to capture the fact that Luganda has no coda nasals unless they are in the first half of a geminate. This constraint is to be understood as satisfied by non-crisp alignment (Itô and Mester 1994), which means that so long as the feature [nasal] does align with the left edge of some syllable, it may also be associated with other segments not at the left edge. Examples of structures satisfying and violating (17a) are given below in (17b). Violation occurs when a [nasal] feature attaches only to a segment at the right edge of a syllable, i.e., in the coda.

(17) a. Align-Left ([nasal], σ): The feature [nasal] is aligned with the left edge of a syllable (i.e., onset position licenses the feature [nasal]).



Prenasalized stops in the output satisfy ALIGN-L(nasal), since the feature [nasal] is associated with the initial segment of a syllable. The high ranking of this constraint, along with MAX- IO(nasal), forces the nasal of the input to attach itself to the following onset. Ranking the correspondence constraint MAX-IO(μ) above IDEN-IO(μ) preserves the mora from the input nasal, but allows it to be attached to the preceding vowel. In the word-internal and phrase-initial cases, once again alignment of words with syllables plays no role.

Tableau 4 Word-internal /mu+ntu/ "person" = [muu^{n}tu]

Candidates	Align-L (nasal)	Max-IO (μ)	Max-IO (nasal)	Iden-IO (μ)	Align-L/R (Wd, σ)
.mun.tu.	*!				
.mu.^{n}tu		*!			
.muu.tu			*!	*	
☞ .muu.^{n}tu.				*	

Tableau 5a Phrase-initial /mva/ "vegetable relish" = [m̩va][4]

Candidates	Align-L (nasal)	Max-IO (μ)	Max-IO (nasal)	Iden-IO (μ)	Align-L/R (Wd, σ)
.^{m}va.		*!			
☞ .m.va.					

In the phrase-internal case, however, in order to have the same prenasalization, the alignment of words and syllables must be violated. The ranking is illustrated in Tableau 5b:

Tableau 5b Phrase-internal /si+agala # mva/ "don't like vegetable relish" = [saagalaa^{m}va]

Candidates	Align-L (nasal)	Max-IO (μ)	Max-IO (nasal)	Iden-IO(μ)	Align-L/R (Wd, σ)
saa.ga.la#m.va	*!				*
saa.ga.la.^{m}#va		*!			
saa.ga.laa.#va			*!	*	
☞ saa.ga.laa.m#va				*	*

Glide-formation compensatory lengthening follows basically the same logic, with the major difference being that the driving force is a constraint against diphthongs, as in (18).

[4] While the syllabic nasal wins phrase-initially, where there is no option of preservation of the mora by association with a preceding vowel, presumably a high ranking constraint against syllabic nasals prevents this option from winning phrase-medially.

(18) No Diphthongs (NoDiph) (Rosenthall 1997)

$$
\begin{array}{cc}
\multicolumn{2}{c}{*\,\sigma} \\
/ & \backslash \\
\mu & \mu \\
| & | \\
V_i & V_j
\end{array}
$$

By the ranking of this constraint above Iden-IO(μ), when two vowels are in hiatus word-internally, the diphthong is avoided but input moras are preserved. As shown in Tableau (6a), alignment is vacuously satisfied in the word-internal case; however, Tableau (6b) reveals that the constraint against misalignment must again rank low so that the same result is found phrase-internally.

Tableau 6a Word-internal /li+ato/ "boat" = [l^yaato]

Candidates	No Diph	Max-IO (μ)	Max-IO (V-feat)	Iden-IO (μ)	Align-R/L (Wd, σ)
.lia.to.	*!				
.l^ya.to.		*!			
.laa.to.			*!	*	
☞ .l^yaa.to.				*	

Tableau 6b Phrase-internal /o+lu+naku # o+lu+o/ "that day" = [olunak^{w}ool^{w}o][5]

Candidates	No Diph	Max-IO (μ)	Max-IO (V-feat)	Iden- IO(μ)	Align-R/L (Wd, σ)
.na.ku#o.l^{w}o	*!*				*
na.k^w#o.l^{w}o		*!*			*
.na.ko#o.l^{w}o			*!*	**	*
☞ na.k^w#oo.l^{w}o				**	*

Thus, for both types of compensatory lengthening, the phonotactic constraints on well-formed syllables, NoDiph and Align-L(nas) rank high to motivate the difference between input and output. The relative ranking of Max-IO(μ) above Iden-IO(μ) allows for the preservation of the mora in a new location, while the low ranking of Align-L/R(Wd, σ) allows for that

[5] A high ranking constraint prevents long-vowels from appearing phrase-finally.

preservation even at the cost of misalignment of the syllable and word boundaries. The overall ranking is thus:

(19) {MAX-IO(μ), NODIPH, ALIGN-L(nas), MAX-IO(nas),MAX-IO(V-feat)}
>> {IDEN-IO(μ), ALIGN-L/R(Wd, σ)}

Note that both types of compensatory lengthening require only general cross-linguistically motivated constraints. In each case, syllabification crosses words to satisfy MAX-IO(μ) plus a syllable well-formedness constraint, either on the coda (ALIGN-L(nas)) or nucleus (NODIPH). The following example shows similarly that sub-segmental units can be syllabified with a different word due to coda constraints; in this case, features rather than moras are misaligned.

3.4 Feature Misalignment in Tamil

Features are a second kind of subsegment that can be shared across word edges due to syllable phonotactics. In Tamil, coda constraints force adjacent word-final and word-initial consonants to share features of place of articulation.[6] In examples (20a-d), we see words with plural suffixes or emphatic clitics; examples (20e-g) are compounds (Christdas 1988). In both cases, word-final nasals assimilate in place to the following obstruent.

(20)	a. /maram+kaɭ/	tree + pl	[mʌrəŋgə]	"trees"
	b. /maram+ taa<u>n</u>/	tree + emph	[mʌrə<u>n</u>dã]	"tree" (emph)
	c. /pasan + kaɭ/	child + pl	[pʌsəŋgə]	"children"
	d. /vayal + taan/	field + emph	[vʌjə<u>l</u>dã]	"field" (emph)
	e. /paɳam#kaas/	money # cash	[pʌɳəŋkasɯ]	"money"
	f. /maram# tʃeʈi/	tree # plant	[mʌrəɲtʃɛɖɪ]	"vegetation"
	g. /koɭam#tooɳʈi/	pond # dredge	[kɔɭə<u>n</u>toɳɖɪ]	"tool for dredging ponds"

In phrases, we see the same phenomenon of nasal place assimilation across words, though phrase-final nasals are deleted (Wiltshire 1998).

(21)	a. mt → nt	/kontʃam/ /terijum/	[kɔɲdʒəntɛrɪujũ]
		little knows	"knows a little"
	b. mk →ŋk	/neeram//kaalam//kiʈajaataa/	[<u>n</u>erəŋkaləŋkɪɖəjada]
		time season there-isn't-<u>qu</u>	"'isn't there a proper time?"
	c. np → mp	/en/ /peer/	[jɛmperɯ]
		my name	"my name"

[6] Note that voice and place assimilation act differently, as voicing assimilation occurs only word-internally. I deal only with place here, since it acts the same in both word and phrase internal positions.

d. nk →ŋk   /avan/ /keekkiraan/   [ʔʌvəŋkekkɪrã]
he   hear-pres-he   "he hears"

To see how this assimilation results in a subsegment being shared across word boundaries, consider the diagram in (22):

(22) Subsyllabic segment crosses word boundaries:

σ σ σ σ σ
C V C C V C]$_{Wd}$[C V C V C V   [kɔɲdʒəntɛrɪjũ]
[cor]

Here the place features from the second word are linked to a coda consonant syllabified with the first word. As in Luganda prenasalization compensatory lengthening, the sharing of a sub- segment is motivated by a coda restriction, here NoCoda$_{Pl}$. This constraint, which is also evaluated to allow non-crisp alignment, requires that each consonantal place of articulation be linked at the left edge of a syllable; hence, a coda consonant may not have a place of articulation distinct from that of the following onset consonant.

(23) NoCoda$_{Pl}$, a.k.a. Align-L(C-Place, σ): each instance of consonantal place aligns with the left edge of some syllable

Place assimilation requires that NoCoda$_{Pl}$ outranks a correspondence constraint on the features of consonantal place, Max-IO(C-Pl). The overall ranking appears in (24), and includes the correspondence constraints Max-IO(C) and Dep-IO(V) .

(24) { NoCoda$_{Pl}$, Max-IO(C), Dep-IO(V) } >> Max-IO(C-Pl).

By this ranking, the consonant is preserved in the output, to satisfy Max-IO(C), but its place features may be deleted, to satisfy NoCoda$_{Pl}$. By ranking Dep-IO(V) high, no epenthetic vowels appear in the output in order to rescue the place features from appearing in the coda. Tableau 7a shows this ranking for stem-final nasals; the alignment constraint on words and syllable edges is not violated by anything involved in the internal assimilation and is left unmarked, though the question of the right edge of phrases is an interesting one, discussed in Wiltshire (1998).

Tableau 7a Word-internal /maram + taan/ "tree" (emph) = [mʌrən̠dã]

Candidates	No CodaPl	Max-IO (C)	Dep-IO (V)	Max-IO (CPl)	Align-L/R (Wd, σ)
.ma.ram.dãã.	*!				
.ma.rã.dãã.		*!			
.ma.ra.mu.dãã.			*!		
☞ .ma.ran.dããn.				*	

As in word-internal assimilation, the same ranking results in phrase-internal assimilation, giving the feature misalignment as shown in (22) above, with the coronal of the second word associated with a consonant at the end of a syllable in the first word.

Tableau 7b Phrase-internal /kontʃam/ /terijum/ "knows a little" = [kɔɲdʒən#tɛrɪjũ]

Candidates	No CodaPl	Max-IO (C)	Dep-IO (V)	Max-IO (CPl)	Align-R/L (Wd, σ)
.koɲ.tʃam.#te.ri...	*!				
.koɲ .tʃa.#te.ri...		*!<m>			
.koɲ.tʃa.mu.#te.ri...			*!(u)		
☞ .koɲ.tʃan̠.#teri...				*	*

Thus, the sub-segmental features of place of articulation cross the word boundary to satisfy NoCodaPl in Tamil.

We have seen throughout section 3 that constraints on any part of the syllable may be responsible for misalignment of word and syllable edges. Onset phonotactics, either requiring or limiting onsets, force segments to cross into a syllable with segments of another word in Spanish and Italian. A constraint on the rhyme, NoDiph, results in material from two words sharing a syllable at the boundary in Luganda. Finally, constraints on the coda play a role in sharing subsegmental features from one word into a syllable of an adjacent word, for moras in Luganda and place features in Tamil. All of these analyses have used syllable constraints which are widely attested cross-linguistically, which is one benefit of an Optimality Theory analysis. In the following section, I will propose that the fully parallel version of OT used thus far has another advantage; it predicts that the word-alignment constraints are present even in grammars in which they are violated because they rank lower than some syllable phonotactic constraint.

4 Comparison with alternatives

Although the observations of the preceding section could be formulated in rule-based or constraint-based accounts in which word-level syllabification precedes phrasal resyllabification, I want to show now how fully parallel OT captures an aspect of word-edge alignment that other such accounts would miss. That is that the constraints in (3) are not turned off, but merely overridden. I will illustrate using Spanish (4.1) and Italian (4.2) examples.

4.1 Spanish alignment in action

In Spanish, word-edge alignment plays a role in phrasal syllabification even though it is violated in some cases. In word-internal cases, we saw that Spanish prefers to syllabify single intervocalic consonants as onsets rather than codas (section 3.1). In fact, word-internally, Spanish prefers to maximize onsets rather than tolerate codas, so that clusters of consonants will be parsed in the onset rather than coda plus onset, if possible.

(25)	a. /soplo/	[.so.plo.]	*[.sop.lo.]	"breath"
	b. /ablar/	[.a.ßlar.]	*[.aß.lar.]	"talk"
	c. /peregrino/	[.pe.ɾe.ɣɾi.no.]	*[.pe.ɾeɣ.ɾi.no.]	"pilgrim"

We also saw that a word-final consonant would syllabify with a following word-initial vowel, so that an intervocalic consonant is always realized as an onset, whether or not the syllable has to cross a word boundary. However, a word-final consonant does not syllabify across a word- boundary if the following word has an onset, even though a well-formed onset would result. Instead, the word-final consonant is parsed in the coda, violating NoCoda.

(26)	a. /klub#lindo/	[.klußˌlin.do.]	*[klu.ßlin.do.]	"beautiful club"
	b. /čef#loko/	[.čef.lo.ko.]	*[če.flo.ko.]	"crazy chef"
	c. /benid#rapido/	[.be.nið.ra.pi.ðo.]	*[be.ni.ðra.pi.ðo.]	"come (pl. imp.) quickly"

Since the following word is consonant-initial and already has an onset, syllabification aligns with the word boundaries, and any word-final consonant is in the coda. This gives the appearance of different rules of syllabification in phrases than word-internally, since a cluster such as /bl/ is treated as a good onset within a word ([.a.ßlar.]), but as a coda plus onset in a phrase ([.kluß.lin.do.]). Accounts which use different levels of syllabification for words and phrases have to postulate distinct syllabification rules (Hualde 1992). However, the generalization is that word edges coincide with syllable edges unless a syllable would lack an onset. Interestingly, the same generalization holds across prefix-edges. Unless a syllable would lack an onset (27a-c), prefix edges coincide with syllable edges (27d-f).

(27)	a. /des+igual/	[.de.si.gwal.]	*[.des.i.gwal.]	"unequal"
	b. /sub+alterno/	[.su.ßal.tér.no.]	*[.suß.a.l.tér.no.]	"subordinate"
	c. /in+esperado/	[.i.nes.pe.ɾa.ðo.]	*[.in.es.pe. ɾa.ðo.]	"unexpected"
	d. /sub+lu.nár/	[.suß.lu.nár.]	*[.su.ßlu.nár]	"sublunar"
	e. /sub+lingwal/	[.suß.liŋ.gwal.]	*[.su.ßliŋ.gwal.]	"sublingual"
	f. /ad+risar/	[.að.ri.sar.]	*[.a.ðri.sar.]	"to right (nautical)"

Although ONSET must outrank the constraints aligning word and syllable edges, these constraints do assert themselves when onset is satisfied, even at the expense of NOCODA. Thus the ranking that simultaneously gives us maximal onsets within words and syllabification across words only in cases in which a word would otherwise be onsetless is shown in (28).

(28) ONSET >> ALIGN-R, ALIGN-L >> NOCODA

Though the word alignment constraints are outranked, they assert themselves if ONSET is already satisfied, as shown in Tableau 8. Word-internal clusters form maximal onsets because of the ranking of ONSET above NOCODA, while word-final consonants do not cross word boundaries to form maximal onsets because of the ranking of the alignment constraints. I analyze prefixes as separated from the base by a prosodic word bracket; arguments for this analysis can be found in Wiltshire (to appear).

Tableau 8 Partial Analysis

Inputs	Candidates	Onset	Align-R (Wd,σ)	Align-L (Wd, σ)	No Coda
ablar	☞ a.ßlar.	*			
'to talk'	aß.lar.	*			*!
klub ~~# eleg~~ante	☞ klu.ß # e.le. ɣan.te.		*	*	*
'elegant club'	kluß# e.le. ɣan.tc	*!			**
klub # lindo	klu.ß # lin.do		*!	*	*
'beautiful club'	☞ kluß.# lin.do				**
des+igual	☞ .de.s # i.gual.			*	*
'unequal'	.des. # i.gual.	*!			**
sub+lu.nár	.su.ß # lu.nár			*!	*
'sublunar'	☞ .suß. # lu.nár				**

Thus, though a word-final consonant may be syllabified differently in different phrasal contexts, rules of resyllabification are not required. Furthermore, we do not need rules of syllabification across word boundaries that differ from those within words, as in the different syllabifications of /bl/ word-internally vs. across words. Instead, the presence of the alignment constraints on word and syllable boundaries provides for different syllabifications in different contexts, although it is overruled if the high ranked ONSET constraint is at stake.

4.2 Italian alignment in action

I now return to *raddoppiamento sintattico* in Italian, illustrated in section 3.2, in which word-final stressed syllables have to be heavy, and use a consonant from the following word if necessary. We saw that if a word began with a geminate or sC cluster, word alignment was violated; these sequences did not form ideal onsets, so the first consonant was syllabified into the coda of the final syllable of the preceding word. However, words that begin with a single consonant or a good onset cluster have a consonant doubled to satisfy PKPROM, the requirement that a stressed syllable is heavy; these were the examples in (11a-b), such as *triste* 'sad', [t͡ʃittáttriste] 'a sad city'. Thus, when the word-initial onset is already acceptable in Italian, word- alignment is satisfied at the expense of DEP-IO(C), the constraint against epenthetic consonants on the surface.

As shown in Tableau 9, due to the ranking of alignment above DEP-IO(C), a good cluster is not broken across boundaries, nor are the word edges realigned or shifted.

Tableau 9 Input: /t͡ʃittá triste/ "a sad city"

Candidates	PkProm	*<4DifSon	Align-L(Wd, σ)	Dep-IO(C)
t͡ʃittá]$_\sigma$[triste	*!			
t͡ʃittát]$_\sigma$[riste			*!	
☞ t͡ʃittát]$_\sigma$[triste				*(t)

However, while /sC/ is treated as a tolerable cluster, phrase-initially, it is only tolerated when nothing better is available. Phrase-medially, following a vowel-final word, the constraint ranking determines that a better option is to break the cluster across words.

Tableau 10 Input: /t͡ʃittá sporka/ "a filthy city"

Candidates	PkProm	*<4difson	Align-L(Wd, σ)	Dep-IO(C)
t͡ʃittá]$_\sigma$[sporka	*!	*		
t͡ʃittás]$_\sigma$[sporka		*!		*(s)
☞ t͡ʃittás]$_\sigma$[porka			*	

Thus, the logic of the ranking is that /tr/ and /sp/ are different because one satisfies *<4DIFSON and the other does not. While the word/syllable alignment constraints are ranked low enough to be violated in order to improve the satisfaction of *<4DIFSON, they still play a role in Italian by encouraging clusters such as /tr/ to stay together, with a DEP-IO(C) violation resulting instead.

Compare this account to Peperkamp (1997), who appeals to levels of syllabification. In her account, the resyllabification of *triste* is blocked by a kind of FAITHFULNESS to previously built lexical syllabifications, so that at the phrasal level, the initial consonant must be doubled to satisfy the weight requirement of the preceding stressed syllable. Such an account would then have difficulty with handling /#sC/ cases, where the equivalent "resyllabification" does happen, misaligning the word boundary by putting a word-initial /s/ into the stressed syllable of the preceding word. That is, if we use two levels and faithfunless to lexical structure and rank it high, we can get [t͡ʃittat.triste] but also *[[t͡ʃittas.sporka], while if we rank faithfulness low, we can get [[t͡ʃittas.porka] but also *[[t͡ʃittat.riste]. A possible alternative analysis to preserve Peperkamp's approach would be to treat the /s/ in an /sC/ cluster as at least temporarily extraprosodic, though extraprosodicity is generally avoided in OT. In this case, it seems to be merely a way to look ahead to the phrasal context, since a special structure is being built lexically for /sC/ clusters in order to accomodate their phrasal syllabification.

The account here, which is also based on Wiltshire and Maranzana (1999), uses independently motivated onset sonority sequencing constraints (Davis 1990), which capture the different behavior of word-initial clusters in the *raddoppiamento sintattico* contexts in Italian. Furthermore, as with Spanish syllabification, we do not require levels of syllabification or resyllabification as in previous rule or constraint-based analyses. Finally, the use of the word/syllable alignment constraints shows a phenomenon that is an essential claim of OT: though constraints may be outranked in a grammar, they will express themselves when the higher ranked constraints are tied.

5 Conclusions

In each case discussed here, the syllabification of words in isolation and in phrases has been shown to result from the same ranked set of constraints within each language; hence resyllabification at word-edges is shown to be unnecessary in a constraint-based account. Syllabification crosses word boundaries to satisfy constraints on syllable markedness (onset requirement, onset, nucleus, and coda restrictions) and IO correspondence at the expense of alignment. In each analysis, the markedness constraints involved are justified cross linguistically, language specifically, and word-internally, so that it should be no surprise to see the role they play across words in phrases.

An OT account is best able to capture the role of the constraints aligning word and syllable edges even in languages in which they are sometimes violated due to higher ranking constraints. Rather than requiring a set of rules ordered with resyllabification, constraints at the edges account for the limitations of cross-word syllabification, and provides for syllabification with independently motivated constraints on prosodic structures, so that OT need not resort to multiple levels, but instead can be a truly parallel system.

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